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Vol. 11, No. 2

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Related to the Silicate Industries

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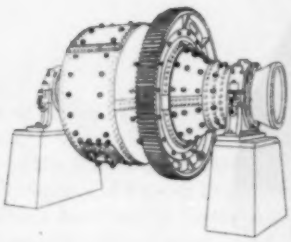

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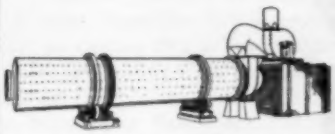

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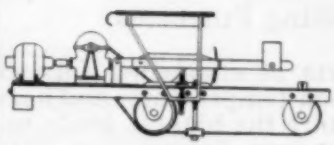

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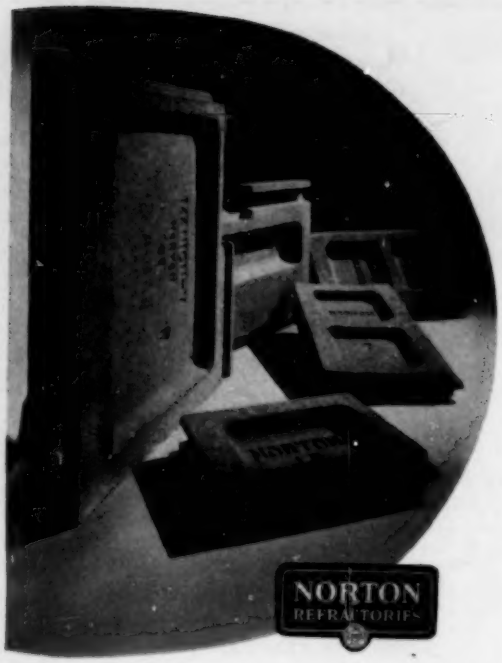

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EFFECT OF FIRING AT 1500°C ON THE POROSITY AND SPECIFIC GRAVITY OF QUARTZITES[1]

By Sandford S. Cole

ABSTRACT

Quartzites from the various deposits being commercially utilized for the manufacture of silica brick in the United States, Canada, and Europe were tested for porosity and apparent specific gravity before and after firing at 1500°C for 2 hours. Petrographic examination was made of several of the raw quartzites, and the differences in crystalline structure are shown by photomicrographs. The rate of conversion of the quartz was not constant for the quartzites reported. The porosity after firing varied from 2 to 30% and the apparent specific gravity varied from 2.30 to 2.44. A fine-grained quartzite tends to give lower porosity after firing.

I. Introduction

The effect of firing raw quartzite to the usual temperature for silica brick was investigated in order to determine the rate of conversion of the quartz, the porosity of the stone before and after firing, and the structure of the fired stone. Similar work has been done by other investigators,[2] chiefly on European quartzites. Information on American quartzites is limited. The data presented are a portion of what has been obtained on more than 150 samples.

Quartzites from practically all commercially-developed properties have been tested, but only typical examples will be presented. Results on quartzites from various deposits representing all large geological formations in this country and Europe are given so that variations in these may be noted. The brick made from some quartzites are of a rather poor grade, so that a mixture of quartzites is used. Blending is practised in eastern Pennsylvania and in Europe.

II. Methods Employed

The porosity and apparent specific gravity of each quartzite was obtained before and after firing for 2 hours at 1500°C. Samples weighing approximately 15 to 20 grams were used and were boiled in water to constant weight for porosity and gravity data. The firing was carried out in a large furnace, the samples being protected from direct flame impingement. The rate of heating was approximately 250°C per hour for the first 2 hours, 100°C per hour for the next $1^1/_2$ hours, then 300°C per hour for $2^1/_2$ hours, and at a rate of 100°C per hour to 1500°C. This temperature was held for 2 hours using a noble metal thermocouple for temperature measurement. The samples were allowed to cool in the furnace to prevent

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Refractories Division). Received August 26, 1931.

[2] See Bibliography, p. 95.

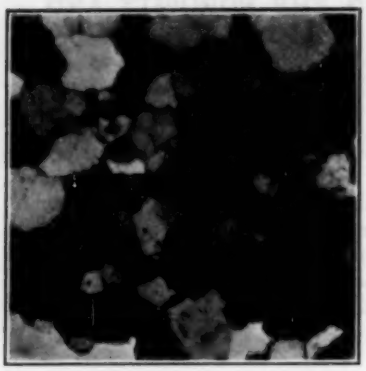

FIG. 1.—No. 23172, Lancaster Co., Pa., 55 ×, cross-nicols, crystalline.

FIG. 2.—No. 23191, Juniata Co., Pa., 55 ×, cross-nicols, crystalline.

any cracking. The heating rate used did not shatter typical quartzites, but certain samples, such as vein quartz, were found to be difficult to heat.

III. Comments on Results

The source of some of the samples and data obtained are presented in Table I. The crystalline structure and the hardness of a quartzite do not seem to have any direct relation to the porosity of fired stone. The size and shape of crystals, or grains, seem to have some bearing, but to state

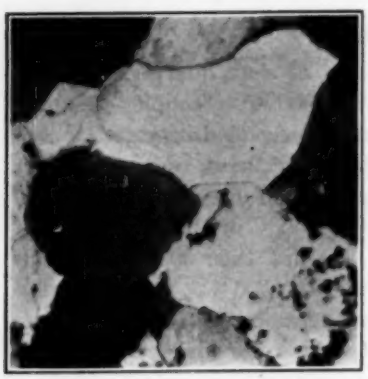

FIG. 3.—No. 18583, Huntingdon Co., Pa., 55 ×, cross-nicols, crystalline.

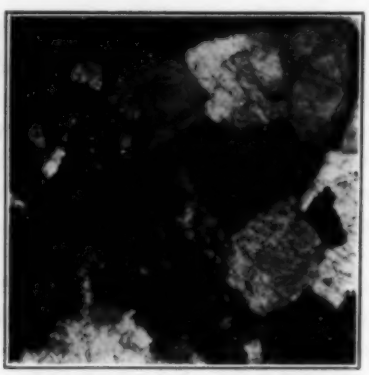

FIG. 4.—No. 22707, Blair Co., Pa., 55 ×, cross-nicols, crystalline.

FIG. 5.—No. 18452, Center Co., Pa., 55 ×, cross-nicols, crystalline.

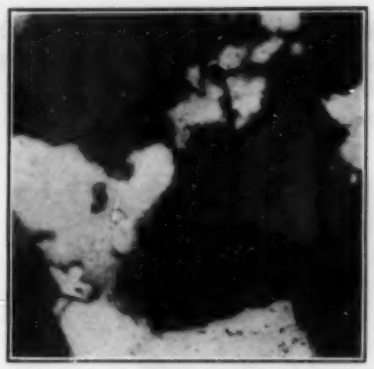

FIG. 6.—No. 23166, Fayette Co., Pa., 55 ×, cross-nicols, crystalline.

this as a rule was not possible after examination of all quartzites. The porosity after firing and rate of inversion appear to be an inherent property of a quartzite. The fine-grained cryptocrystalline quartzites generally converted quite rapidly and gave rather low porosity.

The quartzites of Pennsylvania, except for the Homewood sandstone, tend to give lower porosity data the further west the stone occurs. The rate of inversion is about the same. The quartzite deposits in the Baraboo formation of Wisconsin vary to some extent. The data given cover ap-

FIG. 7.—No. 18453, Alabama, 55 ×, cross-nicols, crystalline.

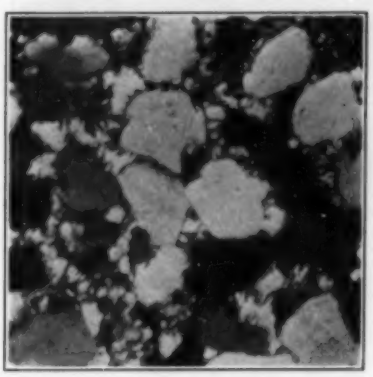

FIG. 8.—No. 18450, Colorado, 55 ×, cross-nicols, crystalline, chalcedonic.

proximately the variation usually encountered. The Colorado stone appeared to contain some chert or chalcedonic silica both inherent and as a bond, which was not encountered in other American quartzites. The Alabama quartzite resembles the central Pennsylvania stone.

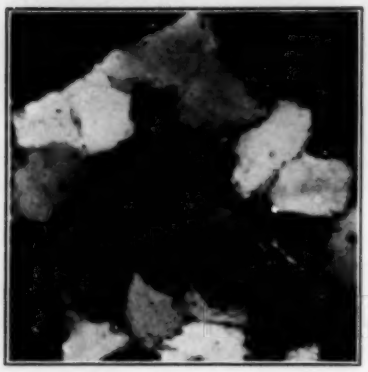

FIG. 9.—No. 21534, Baraboo Co., Wis., 55 ×, cross-nicols, crystalline.

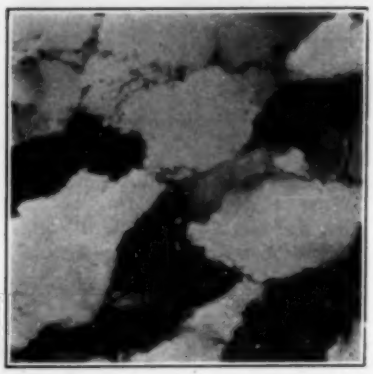

FIG. 10.—No. 23541, Baraboo Co., Wis., 55 ×, cross-nicols, crystalline.

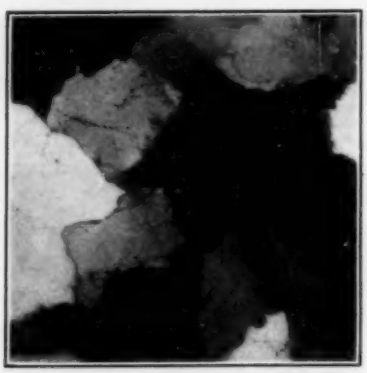

FIG. 11.—No. 22907, Nova Scotia, Canada, 55 ×, cross-nicols, crystalline.

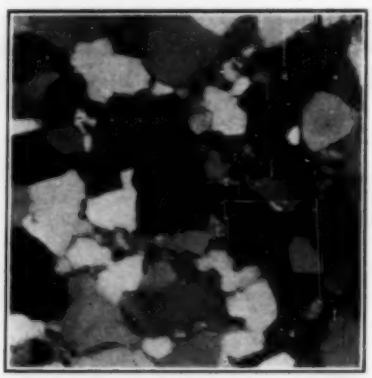

FIG. 12.—No. 22904, Western Ontario, Canada, 55 ×, cross-nicols, crystalline.

The crystalline quartzites of Europe behave in a manner similar to the American crystalline stones. In many instances, impurities such as feldspar and mica were found. The cryptocrystalline quartzite, known in

Europe as "findlings" quartzite, resembles flint fire clay in appearance and fracture, but is very hard. A large portion of the blend used for open-hearth brick and coke-oven wall brick is this "findlings" quartzite in con-

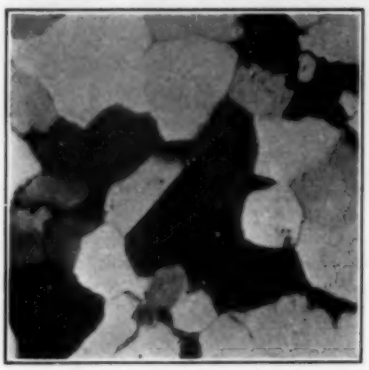

FIG. 13.—No. 18444, North Wales, 55 ×, cross-nicols, crystalline.

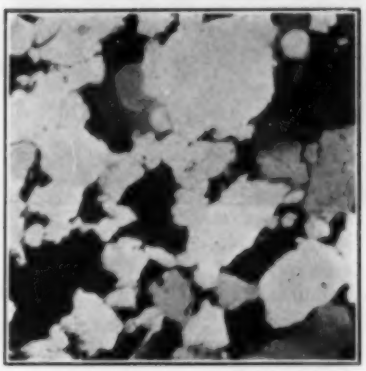

FIG. 14.—No. 18447, Yorkshire, England, 55 ×, cross-nicols, crystalline.

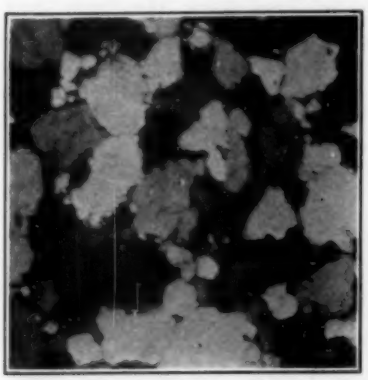

FIG. 15.—No. 18449, Yorkshire, England, 55 ×, cross-nicols, crystalline.

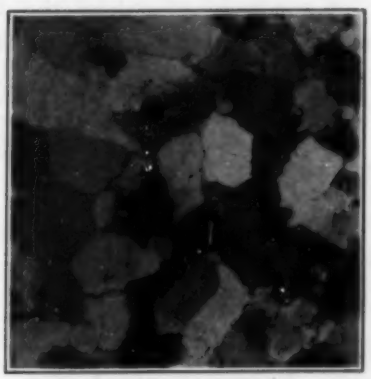

FIG. 16.—No. 18843, Rhineland, carboniferous, 55 ×, cross-nicols, crystalline.

junction with a crystalline stone. The resultant product is extremely hard and strong.

Since all quartzites tested were used in the manufacture of silica brick

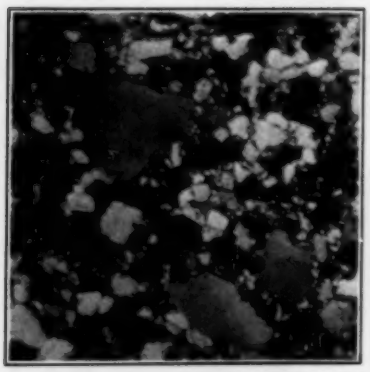

FIG. 17.—No. 18839, Westerwald, Germany, 55 ×, cross-nicols, cryptocrystalline.

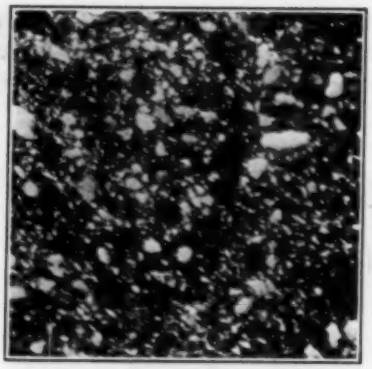

FIG. 18.—No. 18845, Westerwald, Germany, 55 ×, cross-nicols, cryptocrystalline.

having high refractoriness under load, it was not deemed necessary to carry out chemical analyses. The impurities are necessarily low so that the quartzites probably have, within rather narrow limits, the same analysis.

Photomicrographs show the variations in crystalline structure and nature of the bond. The "findlings" quartzites vary in microstructure

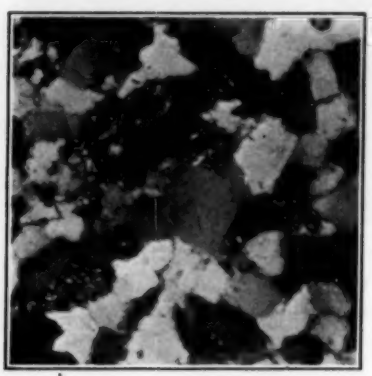

FIG. 19.—No. 18834, Rhineland, Germany, 55 ×, cross-nicols, crystalline.

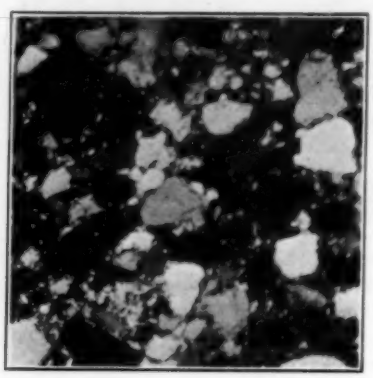

FIG. 20.—No. 18842, Saxony, Germany, 55 ×, cross-nicols, crystalline.

TABLE I

DESCRIPTION OF QUARTZITES AND DATA OBTAINED

Lab. No.	Geographic location	Geological age	Physical appearance	Porosity before firing (%)	Porosity after firing at 1500°C	App. sp. gr. after firing at 1500°C
23172	Lancaster Co., Pa.	Cambrian	Fine grain, crystalline, very hard	0.5	28.8	2.33
23191	Juniata Co., Pa.	Silurian	Sandy, coarse grain, crystalline, rather soft	1.5	21.4	2.33
18583	Huntingdon Co., Pa.	Silurian	Coarse grain, crystalline, rather hard	1.9	15.9	2.33
22707	Blair Co., Pa.	Silurian	Fine grain, crystalline, quite hard	0.7	7.2	2.32
18452	Center Co., Pa.	Silurian	Fine grain, crystalline, quite hard	2.1	8.3	2.36
23166	Fayette Co., Pa.	Upper carboniferous (Homewood)	Coarse grain, sandy, crystalline, very soft	11.3	30.5	2.33
18453	N. E. Ala.	Cambrian	Fine grain, crystalline, rather hard	0.4	15.2	2.33
22750	Baraboo Co., Wis.	Huronian	Coarse grain, crystalline, rather hard	0.2	10.1	2.35
21532	Baraboo Co., Wis.	Huronian	Fine grain, crystalline, very hard	0.2	1.9	2.40
18450	Central Colo.	Cretaceous	Medium fine grain, crystalline, quite hard	4.6	15.2	2.30
22907	Nova Scotia, Can.	Cambrian	Fine grain, crystalline, quite hard	0.2	25.9	2.31
22904	Western Ontario, Can.	Lorrain	Fine grain, crystalline, very hard	0.3	17.7	2.32
18444	N. Wales	Millstone grit	Medium grain, crystalline, rather hard	1.4	13.5	2.40
18447	Yorkshire, England	Millstone grit	Medium grain, crystalline, rather hard	2.8	14.8	2.43
18449	Yorkshire, England	Millstone grit	Fine grain, crystalline, rather hard	10.0	20.5	2.42
18843	Rhineland, Germany	Carboniferous	Fine grain, crystalline, very hard	1.1	10.5	2.39
*18839	Westerwald, Germany	Tertiary	Fine grain, cryptocrystalline, very hard	1.5	4.3	2.32
*18845	Westerwald, Germany	Tertiary	Fine grain, cryptocrystalline, very hard	2.0	4.6	2.31
18834	Rhineland, Germany		Fine grain, crystalline, quite hard	2.6	9.7	2.38
*18842	Saxony, Germany	Tertiary	Fine grain, cryptocrystalline, very hard	1.0	3.2	2.32
18432	Silesia, Germany		Fine grain, crystalline, very hard	1.9	9.2	2.44
*18418	Czechoslovakia	Tertiary	Fine grain, cryptocrystalline, very hard	1.9	3.2	2.32
*18427	Czechoslovakia	Tertiary	Fine grain, cryptocrystalline	0.4	3.7	2.33
*18829	Belgium	Cretaceous	Fine grain, cryptocrystalline, very hard	3.3	9.0	2.31
18833	France	Tertiary	Fine grain, crystalline, very hard	2.3	6.6	2.30
*18426	Czechoslovakia	Tertiary	Fine grain, cryptocrystalline, very hard	1.6	3.8	2.32

The unfired quartzites had an apparent specific gravity of 2.64 to 2.66, except for the chalcedonic stone.

* These cryptocrystalline quartzites are known in Europe as "findlings." These porosity data are for single stones, but checked by duplicate test on the same stone. Differences in quarry do exist, but the stones here reported are typical of each quarry named.

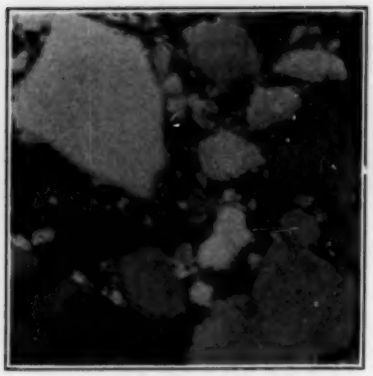

FIG. 21.—No. 18432, Silesia, Germany, 55 ×, cross-nicols, cryptalline.

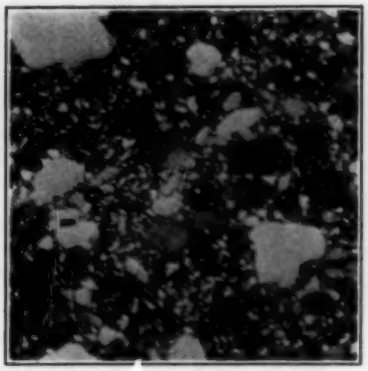

FIG. 22.—No. 18418, Czechoslovakia, 55 ×, cross-nicols, cryptocrystalline.

and are quite distinctive. A marked difference exists between quartzites as can be noted from the photomicrographs.

The following conclusions may be drawn:

(1) The type of crystalline silica composing the quartzites has an effect on the rate of inversion.

(2) Hardness of the quartzite does not determine the porosity of the fired stone.

(3) The nature of the bond as shown by photomicrographs differs for various quartzites.

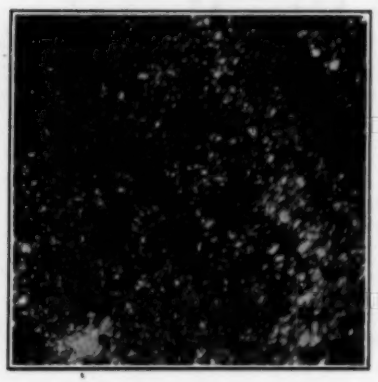

FIG. 23.—No. 18426, Czechoslovakia, 55 ×, cross-nicols, cryptocrystalline.

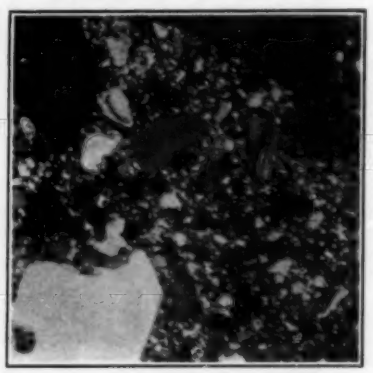

FIG. 24.—No. 18427, Czechoslovakia, 55 ×, cross-nicols, cryptocrystalline.

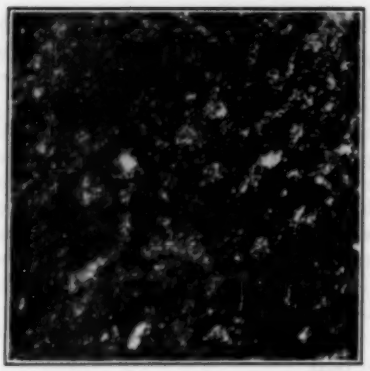

FIG. 25.—No. 18829, Belgium, 55 ×, cross-nicols, cryptocrystalline.

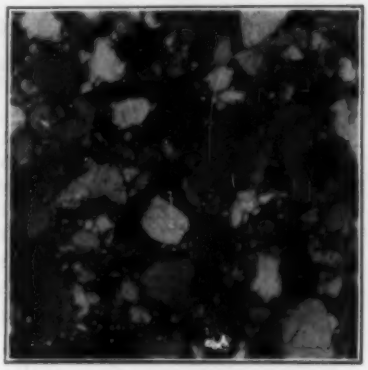

Fig. 26.—No. 18833, France, 55 ×, cross-nicols, crystalline.

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STUDY OF THE SHRINKAGE OF DIASPORE CLAYS, PART II[1]

By Stuart M. Phelps[2]

ABSTRACT

This part of the paper on diaspore deals with the development of methods which will shrink diaspore without firing to exceedingly high temperatures for long periods of time. Experimental work shows that this can be accomplished by a number of shrinkage-producing materials. It is shown that these should be added in definite percentages, and that the greatest shrinking effect will be produced by fine grinding, high pressure molding of the calcine dobies, and by firing to moderate temperatures. The effect of various gas atmospheres during calcining is pronounced. Commercial brick made by the process developed show properties superior to those of regular diaspore brick.

I. Introduction

The usual diaspore refractories possess a residual shrinkage often sufficient to cause service failure at high temperatures or long heat duration. Part I of this subject[3] described studies of ways in which this change takes place. The purpose of Part II was to develop a means of obtaining complete shrinkage in production process, thus making denser and stronger brick, and one having greater slag resistance. This constancy of volume would make the brick less subject to structural spalling and cracking.

Diaspore clay consists of particles of diasporite in a matrix of high alumina clay. Photomicrographs of samples taken during progressive shrinkage show that shrinkage results from shrinking of the bond. The true specific gravity of the mass is changed very little, indicating that the shrinkage does not result from a physical change in the diasporite.

It was conceived that materials might be added, which would serve as mineralizers or mild fluxes, thus hastening shrinkage. The refractoriness of diaspore is, for most purposes, sufficiently high to allow for the resulting slight lowering of the refractoriness.

II. Effect of Various Shrinkage Agents

Samples of diaspores were obtained, covering the physical and chemical property varieties used in the industry. These were ground to pass a 40-mesh sieve and definite percentages of the foreign materials added. Test pieces, $1^1/_2$ by $1^1/_2$ inches, were made, and their volume determined by kerosene displacement. All test pieces were fired to 1400°C in 3 hours and held for 5 hours. The porosity of the fired pieces was determined, and the data given are averages of porosities of at least three test pieces.

The most interesting results of this work are presented in Table I, where the shrinkage ingredients and their percentages are listed according

[1] Received September 17, 1931.

[2] Senior Industrial Fellow, Refractories Fellowship, Mellon Institute of Industrial Research, Pittsburgh, Pa.

[3] S. M. Phelps, *Jour. Amer. Ceram. Soc.*, 9 [10], 659–66 (1926).

to their efficacy. From these findings it will be noted that there are many materials which, in small quantities, will produce appreciable shrinkage. The addition of a given percentage of a shrinkage material does not produce the same effect with each of the diaspores. Those with low and very

TABLE I

SHRINKAGE PRODUCED BY VARIOUS ADDITIONS TO DIASPORE
(Test pieces fired to 1400°C for 5 hours)

Diaspore Sample A

Alumina content 54%			Silica content 28%		
Materials added	Volume shrinkage (%)	Porosity (%)	Materials added	Volume shrinkage (%)	Porosity (%)
Untreated	23.7	27.7	2% magnesia	29.3	29.6
Untreated and after 11 heatings	31.6	21.6	5% aluminum phosphate	26.9	30.9

Diaspore Sample B

Alumina content 72%			Silica content 9%		
Untreated	14.4	28.0	10% sodium silicate solution	25.6	34.0
Untreated and after 11 heatings	33.3	21.7	4% lime	27.1	34.2
5% aluminum acetate	17.9	42.4	5% calcined potash alum	28.2	37.0
1% trisodium phosphate	18.8	43.0	5% cryolite	28.4	
5% aluminum phosphate	19.6	43.7	5% magnesium pyrophosphate	30.3	29.0
3% litharge	19.6	43.8	6% phosphate rock and 4% graphite	30.6	33.6
5% aluminum borate	19.7	45.8	5% Canadian apatite	31.6	23.8
10% feldspar	20.7	41.8	10% phosphate rock	32.1	25.4
5% alunite	23.0	38.0	2% magnesia	32.3	32.0
2% phosphate rock	23.0	36.0	5% phosphate rock	32.8	26.9
2% Canadian apatite	24.0	35.9	10% aluminum phosphate	35.6	35.9
1% magnesia	24.1	39.1	5% magnesia	39.9	27.6
5% bottle glass	24.3	33.8			
5% dry sodium silicate	25.4	34.4			

Diaspore Sample D

Alumina content 79%			Silica content 3%		
Untreated	15.2	45.2	10% sodium silicate	15.2	42.7
Untreated and after 11 heatings	26.2	39.4	5% Canadian apatite	15.7	45.3
1% trisodium phosphate	12.0	47.3	2% magnesia	18.9	46.3
3% litharge	12.3	47.5	10% magnesia	19.6	47.6
10% feldspar	13.9	45.0	10% aluminum phosphate	20.7	44.0

Diaspore Sample C

Alumina content 74%			Silica content 8%		
Untreated	13.3	45.1	2% magnesia	25.2	35.6
5% rutile	10.8	45.4	2% Indian magnesite	25.4	37.7
5% aluminum fluoride	12.1	46.1	2% Californian magnesite	26.2	37.6
5% zinc oxide	15.3	44.7	4% calcium carbonate	27.2	36.9
5% fritted borax	17.6	42.3	4% lime	27.6	37.0
5% barium oxide	19.8	41.6	5% phosphate rock	27.6	33.7
2% phosphate rock	20.2	39.8	10% phosphate rock	31.8	27.8
5% cryolite	22.4	37.5	10% calcium carbonate	32.7	37.2
2% Austrian magnesite	24.4	37.0			

high alumina content do not respond to treatment as readily as those having intermediate content of alumina. This probably results from the amount and nature of the clay matrix, as well as the high porosity of the high alumina diaspores.

(1) Magnesia The first material to be studied to any extent was magnesia, because it appeared to be effective even when added in low percentages. Dobies containing 2% of magnesia were prepared and, after calcining at 1400°C, were crushed for use as grog. These dobies were exceedingly dense and tough, characteristics also exhibited by the finished brick. The graded grog particles were bonded with a high-alumina clay and 9-inch brick were molded and fired to cone 13. Very little shrinkage occurred during the firing, and subsequent reheatings to 1500°C showed little change. The brick behaved poorly in the 1350°C load test, showing that the magnesia glass lowered the refractoriness beyond practical limits. The P.C.E. value, however, was almost equal to the original diaspore. These findings were later substantiated by brick made at a plant, and for these reasons, magnesia was not considered further.

(2) Wavellite Aluminum phosphate appeared promising but, being chemically prepared, it is too expensive, and the mineral wavellite is not mined to any extent. Large-scale tests, therefore, were not conducted. It would have the advantage of not contaminating the diaspore, and may even increase the refractoriness.

(3) Phosphate Rock Phosphate rock seemed to be the next most practical material, since it is available in large quantities at a reasonable price. Large deposits of phosphate rock are worked in Tennessee and Florida and used in fertilizers. Typical analyses of the material are given in Table II.

TABLE II

ANALYSIS OF TYPICAL PHOSPHATE ROCK

	Florida rock (%)	Tennessee rock (%)
Lime	48–50	45–47
Phosphoric pentoxide	31	31
Fluorine	3.0– 3.5	3.5– 3.8
Iron oxide and alumina	2.0– 3.0	5.0
Carbon dioxide	6.0	4.0
Acid insoluble	6.0– 9.0	8.0–10.0
Approximate cost at mine (long ton)	$3.50	$5.00

III. Methods to Produce Maximum Shrinkage in Diaspore Grog

(1) Effect of Phosphate Rock Since the various types of diaspore require different amounts of shrinkage material, a series of mixes was used in which the phosphate rock varied from

1 to 5%. Test pieces made from these were fired at 1300°C, 1400°C, and 1500°C, obtaining the data presented in Fig. 1.

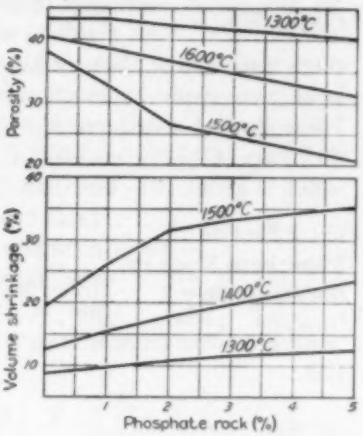

FIG. 1.—Diaspore "E." Effect of increasing amounts of phosphate rock and temperature of firing volume change and porosity.

(2) Fine Grinding The benefit of fine grinding in producing shrinkage of untreated diaspore was shown in Part I, and this holds to a still greater degree for shrinkage-producing mixtures. In the laboratory work, 20-mesh grinding was used, keeping in mind plant practice. The density of the unfired dobies has an important effect upon the amount of calcining shrinkage, as is shown in the data of Fig. 2. The only variable in these experiments was the water content of the mixes and the pressure used in molding. The hand-made pieces were molded in the usual way, while the machine-made mix was pressed under 2000 pounds per square inch.

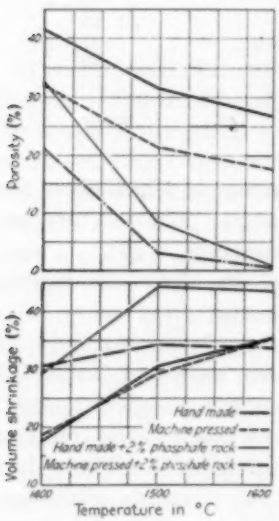

FIG. 2.—Diaspore "E." Effect of molding pressure on shrinkage.

These data and other experiments show clearly the desirability of an intimate mixture of the shrinkage material and the diaspore. Shrinkage is enhanced by fine grinding, careful mixing, and molding to form a dense body before calcining.

The temperature of calcining should be as high as is practicable, but in laboratory trials excellent calcine was obtained from the 1400°C reheat. This material was dense and very tough, making it difficult to crush.

IV. Method Using Calcine

(1) Grog Size The manner of using preshrunk calcine depends upon the properties desired in the brick. Maximum constancy of size will be obtained by making the densest possible brick with as little plastic clay as is practicable. This means that the grog particle sizes should be so graded as to fit together with the least percentage of voids. The grog sizes used to obtain maximum density were 60% of 4- to 12-mesh and 40% of 20-mesh.

(2) Bond Clay Proportion Many types of bond clay can be used in different percentages to secure strength, density, spalling resistance, or rigidity at high temperatures. One of the best clays used was a plastic clay containing 55% of alumina. A number of brick were made by hand, using 25% of this clay, and fired to cone 13. These showed a deformation of 3.8% in the 1350°C load test and a linear shrinkage of 0.72% in a 1500°C reheat for 5 hours. The porosity was 23%, which is about 10% less than the percentage porosity of commercial brick.

(3) Effect of Phosphate Rock in the Bond Clay Trial brick containing 10 to 15% of finely-ground sillimanite gave interesting results, by reason of low shrinkage or even a small expansion. The use of a small amount of phosphate rock in the bond gives too dense a brick to withstand spalling, and shows a poor load test.

V. Plant Experiments

The laboratory results were so encouraging that several tons of calcine were prepared under plant production conditions. The diaspore used gave the following analysis on calcine basis.

	(%)		(%)
Silica	17.30	Lime	1.48
Alumina	73.10	Magnesia	0.27
Iron oxide	1.56	Alkalis	1.33
Titania	3.17	P_2O_5	1.46
			99.67

This material was ground to pass a 20-mesh screen, to which there was added 2% of 100-mesh commercial phosphate rock. The mixture was made into 9-inch brick-sized dobies in an auger machine.

(1) Effect of Calcining Heat Intensity on Calcine The dobies were fired in three commercial kilns ranging in temperature from cones 12 to 18. The properties of the calcine obtained from these heat treatments are shown in Table III. Samples of the fired dobies were sent to the laboratory and given a 1400° reheat for 5 hours, as well as a 1550° test for seven hours. The resulting volume shrinkage and porosity are given also in Table III. These data show the necessity of high-temperature firing for complete shrinkage. The special firing to cone 32 was accomplished in an oil-fired test-size laboratory kiln.

(2) Effect of Kiln Atmosphere Calcine Although the temperature of firing the dobies in the silica brick kiln was considerably higher than that used in the laboratory in preparing calcine, they did not show the density or hardness of those prepared in the labora-

tory. Tests conducted at other plants confirmed this result on every occasion. This discrepancy between plant and laboratory firing was attributed to the nature of the kiln atmosphere.

(3) Brick Tests The calcine, which was fired to cone 17 in No. 2 silica kiln, was crushed and used in the preparation of a quantity of 9-inch brick. Table IV presents the composition and the properties of these brick, which were made by hand and re-pressed.

TABLE III

DATA ON CALCINED PHOSPHATE—DIASPORE MIXES

Material	Porosity (%)	Bulk density	Volume shrinkage (%) after refiring to		Porosity (%) after refiring to	
			1400°C 5 hrs.	1550°C 7 hrs.	1400°C 5 hrs.	1550°C 7 hrs.
No. I silica brick kiln firing						
Cone 16	31.5	2.26	0.4	13.4	31.2	20.9
Cone 17	26.5	2.40	0.4	9.0	26.5	20.5
Cone 18	23.1	2.52	0.5	8.2	23.1	17.0
No. II silica brick kiln firing						
Cone 17	26.2	2.47	0.6	12.3	26.9	12.4
Clay brick kiln firing						
Cone 12	37.0	2.00	2.2	21.4	36.5	17.3
Special firing						
Cone 32	12.4	2.70	+0.6	+0.7	12.7	10.2

It will be seen that calcine was prepared with two degrees of grind, and that three types of bond clay were used. Mixes A, B, and C contained the specially prepared calcine, while mixes AA and BB contained the calcine regularly used in the preparation of diaspore brick. It should be noted, however, that mixes AA and BB contain considerably more alumina than the special calcine. For this reason, the two lots are not strictly comparable. All the brick received a plant firing to cone 10.

Samples D and E are commercial diaspore brick, while sample F is a high-grade general purpose clay brick, which is also included for the sake of comparison.

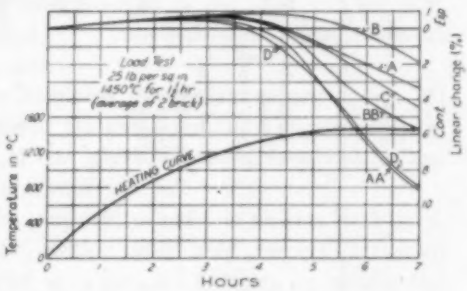

FIG. 3.—Deformation of brick under compression in 1450°C load test.

These data show, in comparison with the control brick, that the porosity of the special brick is lower, the transverse strength is considerably higher, and the deformation under load is lower. Figure 3 presents a graph showing the subsidence of the brick in the standard load test. They behaved

TABLE IV

COMPOSITION AND PROPERTIES OF SPECIAL AND REGULAR DIASPORE BRICK MADE BY COMMERCIAL METHODS

Composition		A	AA	B	BB	C	D	E	F
Special calcine	4–12 mesh	48%				48%			
Special calcine	20-mesh	32%				32%			
Special calcine	No. 4 grind			50%					
Raw diaspore				30%	30%				
Regular calcine	No. 4 grind		80%		50%				
Cone 32 bond clay	12-mesh					20%			
Cone 32 bond clay	12-mesh			20%	20%				
Cones 33–34 bond clay	12-mesh	20%	20%						
Properties									
Silica		24.5%	20.8%	26.2%	21.7%	30.5%	16.6%	22.5%	52.8%
Alumina		66.6%	72.7%	66.4%	71.0%	61.6%	76.7%	71.2%	41.3%
Iron oxide		1.87%	1.30%	1.55%	1.15%	1.89%	0.97%	1.13%	1.89%
Titania		3.20%	3.30%	2.90%	3.60%	2.90%	3.50%	2.78%	2.06%
Weight/cubic foot (lb.)		136	121	131	120	137	122	124	123
Porosity (%)		30	38	31	37	26	35	33	18
Transverse strength (lb./in.)*		1200	1100	1950	860	1625	425	1050	850
Deformation in load test at 1450°C under 25 lb. pressure**		−4.7	−9.4	−3.8	−6.9	−6.0	−9.6	−6.5††	−5.5††
Service spalling test (1st treatment)*		0%	0%	1%	0%	0%	0%		13%
Service spalling test (2nd treatment)*		2%	3%	3%	0%	15%	4%		28%
Shrinkage after 5 hr. at 1400°C		+0.38	−0.40	+0.82	+0.22	+0.25	−1.06		+1.47
Shrinkage after 5 hr. at 1500°C		+0.04	−1.84	+0.73	−1.15	+1.10	−2.81		
Shrinkage after 5 hr. at 1600°C		−2.16	−5.44	−1.61	−4.18	+0.25	−7.51		
Ratio of resistance to coal ash slag***		1.04	1.29	0.96	1.09	0.98	1.25		

* Average of 5 brick.
** Average of 2 brick
*** Average of 3 brick
†† Standard load test at 1350°C.

essentially the same in the service spalling test, with the exception of mix C, which showed fairly high loss. The shrinkage in the 1400, 1500, and 1600° reheating tests is considerably lower for the special brick, as compared with control brick and regular diaspore brick.

The slagging test was conducted through the courtesy of R. K. Hursh.[4] In this test 175 pounds of Illinois coal ash were used in the 24-hour period of the test, with an average temperature of 1600°C. The furnace atmosphere during the test averaged 12.5% carbon dioxide, 2.0% oxygen, and 1.4% carbon monoxide. The ratio of resistance in the slag test is given, and from this it will be seen that the special brick were the most resistant.

VI. Effect of Atmosphere During Calcining

It is evident from the plant trials that preshrinking the diaspore produces brick of superior properties. It is believed, however, that these experiments did not do the method justice, inasmuch as better brick have been prepared in the laboratory. The principal reason for this difference is that the calcine fired in the commercial kilns did not have the properties of the laboratory product. It has been shown repeatedly that the high temperatures and longer period of treatment in the commercial kilns do not produce the shrinkage, density, or hardness of the laboratory firing. It appears that the difference might lie in the nature of the kiln atmosphere, and this belief prompted a study of the effect of gas atmosphere on the shrinkage of the treated and untreated diaspore.[5]

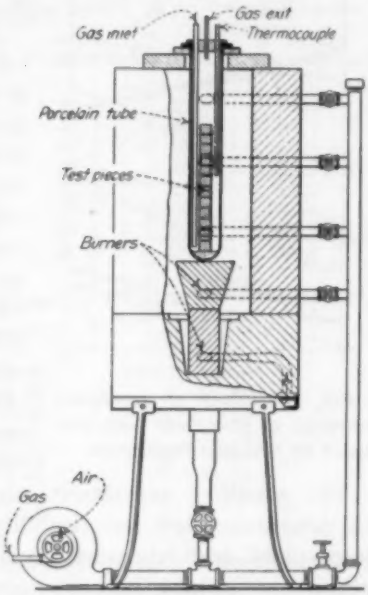

FIG. 4.

(1) Laboratory Studies

A diagram of the apparatus used is shown in Fig. 4. A porcelain tube, which will hold twelve $1^1/_2$-inch cubes, is arranged in a special furnace in which the temperature can be controlled so as to be uniform from top to bottom. The gas to be used during the experiment is fed through the porcelain tube to the bottom test piece, the outlet being at the top. The temperature is controlled inside the tube by means of a thermocouple. At the start of

[4] University of Illinois, Eng. Expt. Sta., *Circ.*, No. 17.
[5] These experiments were conducted by Vance Cartwright, Industrial Fellow, Refractories Fellowship, Mellon Institute of Industrial Research, Pittsburgh, Pa.

a run the pure gas was fed into the porcelain tube at the rate of 3 cubic feet per hour, and the temperature of 1400°C was reached in 3 hours and held for 5 hours.

The diaspore samples used in the work are designated as *X* and *Y*, and have the composition given in Table V. These samples are not particularly susceptible to shrinkage treatment, especially sample *X*. Their behavior, when calcined at two temperatures and with varying percentages of phosphate rock, is shown in Fig. 5.

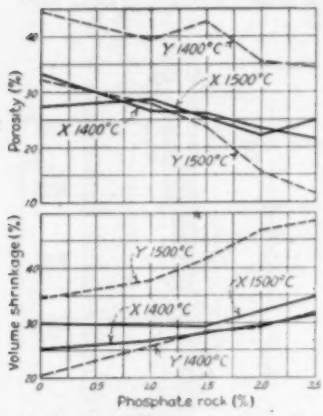

FIG. 5.—Effect of increasing amounts of phosphate rock produced by two heat treatments.

In each run under gas treatment, several cubes of each mix were included, and the average results obtained from the various gases are given in Table V. These data are indicative of the important effect that the kiln atmospheres may have during the calcining of diaspore. The untreated diaspores are not as much affected by the gases as are those containing the phosphate rock. It is reasonable to expect that other shrinkage-producing materials would also be affected, and this expectation opens another avenue for experimentation, not to mention the possibilities in the field of other refractory materials.

The gas-effect experiments should be continued in commercial kilns to determine their practicability. The difference in calcine obtained from plant and laboratory firing is undoubtedly the result of atmosphere, and it may become necessary to control this variable carefully in order to produce a highly preshrunk calcine.

VII. Conclusions

From the data that are given it is evident that much can be expected from the preshrinking of diaspore by the use of certain shrinkage-producing materials and control of kiln atmospheres.

This work should be supplemented by experiments in plant practice, making modifications from the regular plant procedure where such action is necessary.

It is believed that if careful use is made of the principles of the process the manufacturer will be more than repaid for the trouble which may be necessary in carefully controlling his product. This control, however, should be welcomed by the producer of diaspore refractories, because of the large variation in the raw materials, not only in the alumina content and

physical characteristics, but also in the amount of shrinkage which takes place during present manufacturing operations.

It is proposed that samples be taken of stock piles of suitable size, and that these be subjected to shrinkage experiments in the laboratory, so as to learn the proper amounts of phosphate rock which should be added.

TABLE V

EFFECT OF VARIOUS GAS ATMOSPHERES IN THE SHRINKAGE OF DIASPORE

Gas treatment while being fired to 1400°C; temperature held for 5 hr.	Volume shrinkage (%)			
	Diaspore *X*		Diaspore *Y*	
	100%	98% and 2% phos. rock	100%	97½% and 2½% phos. rock
Gas-fired test kiln (neutral to oxidizing)	25.4	29.5	20.6	31.5
Oxygen atmosphere	25.2	31.9	21.8	28.7
Natural gas	23.2	30.7	16.4	34.3
Hydrogen atmosphere	28.2	32.0	31.9	45.7
Water vapor atmosphere	24.7	35.1	22.0	33.2
Carbon dioxide atmosphere	26.3	33.8	23.0	43.5
Carbon monoxide atmosphere	27.5	38.1	23.5	44.1
Sulphur dioxide atmosphere	26.7	39.8	18.4	34.9

CHEMICAL ANALYSES OF DIASPORES *X* AND *Y*

	Diaspore *X* (%)	Diaspore *Y* (%)
Silica	22.50	6.16
Alumina	69.59	87.91
Iron oxide	0.88	0.73
Titania	3.18	3.70
Lime	0.09	0.16
Magnesia	0.48	0.15
Alkalis	2.88	0.64

These and other control methods conducted throughout the manufacturing process would enable the manufacturer to produce a uniform and high-grade product.

Brick have been made in the laboratory that exhibit properties equal to those of many of the highest type of super-refractories, and such a product could be duplicated in the plant and sold for a price considerably under those of present-day super-refractories.

VIII. Summary

(1) Sufficient experimental data have been given to show the preferability of producing a highly preshrunk diaspore by the proper use of suitable shrinkage-producing materials. In order to accomplish an equivalent shrinkage without the aid of foreign materials, it would be necessary to fire the diaspore at exceedingly high temperatures and for long periods of time, which would be too costly.

(2) The material which appears to be most practicable for the preshrinking is known as phosphate rock (essentially tricalcium phosphate). This material is available in large quantities and at low price.

(3) Maximum shrinkage is produced when the proper amount of shrinkage material is used, and by the aid of fine grinding, thorough mixing, molding of calcine dobies by high pressure, and firing to cones 18 to 20.

(4) Experimental data show conclusively a pronounced effect on shrinkage of gas atmosphere during firing. It is reasonable to believe that a similar effect may be found to take place in commercial kilns, even though the gases may be present in smaller percentages.

(5) Commercial brick made by the process possess properties that are superior to those of the regular products. But full advantage of the value of the process has not been taken in this work.

Acknowledgments Acknowledgment is made to M. C. Booze for many helpful suggestions given in the early part of the work, to A. C. Hughes for conducting many of the experiments, and to Vance Cartwright for the work on gas atmosphere.

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THE PRODUCTION OF PAVING BRICK BY THE DRY-PRESS PROCESS[1]

By J. Otis Everhart

ABSTRACT

Comparative tests of stiff-mud and dry-pressed ware have been made and data are given showing the effect of pressure, moisture content, and evacuated molds.

I. Introduction

There are several reasons which make it desirable to dry press paving brick. Specifications of size tolerance are becoming increasingly severe, fired dimensions may be controlled within a few thousandths of an inch, drying shrinkage is especially low, and there is definitely less kiln marking in the finished product. It is possible in some instances to eliminate drying and often little treatment other than screening and grinding is necessary to conc on the material for forming the brick.

There are four major variables in dry pressing brick from a given material, (1) forming pressure, (2) rate of pressing, (3) moisture content, and (4) grain size. The first three are more or less interrelated. High forming pressures, moisture content, and rapid pressing tend to produce pressure cracking, while reduction in any one of these tends to reduce pressure cracking.

The work covered in this paper includes a study of the effect of the variation in moisture content, forming pressure, and forming in evacuated molds. A study of the grain size and its effect on the finished product has been outlined, but is not yet completed. Another study of the exact effect of dry pressing on the firing range of the finished product is also being conducted.

Materials were furnished by two Ohio plants and the Roseville State Brick Plant. In all cases brick were returned for firing in the plant from which the material was secured.

II. Effect of Forming Pressure on Firing Behavior and the Rattler Test

(1) Canton Shale

The first tests were made on a shale from Canton, Ohio, prepared in the same manner as material for the stiff-mud pavers made by the manufacturer supplying the shale.

Brick were pressed from two batches at 885, 1670, 2670, and 3545 pounds per square inch forming pressure. The moisture content was found to be 2.75% for the dry batch and 7.4% for the wet batch. A corresponding group for each pressure was pressed in an evacuated mold.

The brick were fired to 2000°F and given the rattler test at the plant. There was a decrease in rattler loss with an increase in forming pressure

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Structural Clay Products Division).

up to a certain limit. Beyond that, there was an increase in rattler loss due to horizontal laminations resulting largely from entrapped air.

NOTE: Pressure cracking is a term commonly applied to the horizontal laminations induced in the structure of the ware at the time of pressing. The ordinary dry press has an arrangement for raising and lowering the bottom of the mold box so that varying amounts of material may be added by the feeder. If the operator observes these laminations becoming apparent on the surface of the ware, the bottom of the box should be raised, thus decreasing the amount of material added and consequently lowering the ultimate forming pressure.

Examination of the brick after testing showed that there were no pressure cracks in the 885-pound per square inch series, but at 1670 pounds per square inch and above they were increasingly apparent.

Rattler losses as low as 15.31% were obtained.

(2) Southeastern Shale The second shale was secured in southeastern Ohio. It was ground according to the usual plant method, shipped to the Roseville Station, and adjustments made as to its moisture content. Two batches were prepared: one containing 3% moisture and the other, 8%. The more moist series was pressed in four groups at 885, 1330, 1670, and 2670 pounds per square inch, respectively, while that containing less moisture was pressed at 1670, 2670, 3545, and 4450 pounds per square inch pressure.

The rattler losses of the batches are as follows:

Pressure (lb./sq. in.)	Batch (8% moisture) (% rattler loss)	Batch (3% moisture) (% rattler loss)
885	29.5	
1330	24.1	
1670	19.8	25.4
2670	38.7	18.7
3545		19.4
4450		18.9

(3) Roseville Shale The third shale was a local product taken from the Roseville State Brick Plant storage bins and was exactly the same as that used for stiff-mud pavers. Moisture content was adjusted to 8% and the ware was pressed at 440, 885, 1330, 1670, 2170, 2670, and 3107 pounds per square inch forming pressures under normal operating procedure, and at 3107 and 3765 pounds per square inch in evacuated molds. They were fired in plant-production kilns with stiff-mud pavers made at the same time from the same material. The results were as follows:

Ware	(Lb./sq. in.)	Rattler loss (%)
Stiff-mud		24.99
Dry-press	440	30.47
Dry-press	885	22.78
Dry-press	1330	21.87
Dry-press	1670	20.00
Dry-press	2170	22.53
Dry-press	2670	23.23
Dry-press	3109	25.37

Inasmuch as the brick were placed at the top of the kiln there were no signs of kiln marking on the specimens, except those pressed at 440 pounds per square inch. The stiff-mud pavers, placed in the same position, showed considerable kiln marking.

Lamination was again evident in increasing amount as forming pressures were increased.

III. Effect of Moisture Content of the Material

The effect of moisture in the body on resistance of the brick in the rattler test gave the following results:

Moisture (%)	Rattler loss (%)
Brick pressed at 1330 lb./sq. in.	
3	24.84
5	19.32
7	20.34
9	21.09
Brick pressed at 2170 lb./sq. in.	
3	21.65
5	16.48
7	19.22
9	21.77

That the effect of higher pressures may be obtained by increasing the moisture content is evident.

An increased moisture content within certain limits produces ware with a lower rattler loss. Beyond this limit the increased lamination which is set up offsets the advantages of increased density.

From the other tests it seems apparent that with certain bodies a more uniform product may be obtained over a greater range of pressures by using a fairly dry body. With other materials it is practically impossible to secure satisfactory results with low moisture content.

With the presses now employed in plant practice, it seems necessary to add considerable moisture to secure the results which might be obtained by using higher forming pressures.

IV. Effect of Evacuating the Mold

In the first series of tests undertaken, each group of brick pressed at the various pressures was compared with a similar group pressed from the same material and under the same conditions, except that the mold box was evacuated.

In later work done on the Roseville shale an extra series was pressed at 440 pounds per square inch intervals from 440 to 3110 pounds per square inch forming pressure. At 3110 pounds per square inch, "pressure cracking" had become so bad as to be visible on the surface of the ware.

Another series of ten brick were formed at 3110 pounds per square inch in an evacuated mold and no visible pressure cracks were observed. The

forming pressure was then increased to 3765 pounds per square inch pressure without visible lamination. Rattler losses on both of the latter series showed improvement over the unevacuated. Even those pressed at 3765 pounds per square inch pressure in the vacuum were better than those pressed at 3110 pounds per square inch in normal practice.

In every case where evacuation of the mold box was compared with normal pressing a decided improvement was noticed. This improvement is greater when higher pressures and higher moisture contents are being used. Even those brick pressed at very low pressures, however, showed decided improvement when pressed under vacuum.

Improvement in rattler loss on all specimens tested averaged 1.61 in per cent of the rattler loss over those pressed under normal practice. It can be expected, therefore, to lower the normal rattler loss on the average material used. If a certain body formed under certain conditions had a rattler loss of about 20%, the loss might be expected to be reduced approximately to 18.4% by evacuating the mold box.

Probably one of the greatest advantages to be obtained by evacuation is the extension of the permissible range of moisture content and forming pressure in which satisfactory ware can be produced.

V. Effect of Operating Speed

Work on refractory bodies has shown that slowing up of the press cycle has the same effect as reduction in moisture content or forming pressure as far as pressure cracking is concerned. The effect of slowing up the speed of operation is one of allowing the air to escape while the pressing cycle is progressing. When faster operation is carried out the mold is sealed before this air escapes and consequently lamination results.

VI. Abrasion Tests

A few brick have been subjected to abrasion tests. The most notable observation from the tests is the great difference in hardness or resistance to abrasion between the top and bottom of the brick.

NOTE: In the particular press used in these tests all of the movement is supplied by the bottom ram, the top plunger remaining stationary. The female section of the die or mold proper is floating and gives somewhat the effect of movement in the top ram, but this is only relative.

On an average, the bottom of the brick, from which side all of the movement comes, will resist abrasion approximately 30% more than at the top. This evidence seems to indicate the need of a press in which the pressure is applied from both sides:

VII. General Conclusions

(1) With the material used it was possible to produce brick by the dry-press method that meet standard specifications for rattler loss.

(2) In all cases observed where a comparison could be made, brick were produced by the dry-press process having a lower rattler loss than those made by the stiff-mud process. In the case of one plant where stiff-mud brick had never been made (except with difficulty) of sufficient quality to meet the specifications for the rattler test, they were made quite easily by the dry-press method.

(3) There appeared to be more kiln marking in dry-pressed brick formed at low pressures (*i.e.*, at less than 885 pounds per square inch pressure) than in stiff-mud brick. But in dry-pressed brick formed at 885 pounds per square inch and upward, there was definitely less kiln marking than in stiff-mud brick.

(4) An increase in forming pressure produced a decreased rattler loss until a certain maximum pressure was reached; beyond that there was an increase in rattler loss due to lamination set up within the structure of the brick.

(5) Starting at zero water content and increasing the moisture content of the body also produced brick having a lower rattler loss until a certain limit was reached. Beyond this limit more moisture was productive of greater lamination and hence a higher loss in the rattler.

(6) In certain cases better ware was produced over a greater range of forming pressure with comparatively dry material. In other cases, with different shale, the opposite was true.

(7) Evacuation of mold boxes has always resulted in lower rattler losses.

(8) There is a greater difference in resistance to loss by abrasion between the two faces of a brick. Pressure should be applied to both faces of the ware through movement of both the upper and lower rams.

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APPARATUS FOR TESTING ENAMELS AND GLAZES FOR RESISTANCE TO CRAZING UNDER THERMAL SHOCK[1]

By C. J. Kinzie

ABSTRACT

A detailed description is given of apparatus to be used for testing enamels and glazes for resistance to crazing under thermal shock. Flat pieces are recommended for the test and the temperature requirements are given.

I. Introduction

A survey was made of the literature published and the experimental apparatus for testing enamels and glazes for resistance to crazing under thermal shock.

R. D. Landrum[2] describes a method for testing enamels on hollow ware for resistance to thermal shock, the method still being used for tests on cooking ware. H. Harkort[3] tested white ware for resistance to crazing and noted that the temperature in the furnace was not the same in all parts, which accounted for the inconsistent results in his work. The author[4] tested flat enameled surfaces for resistance to thermal shock, but the apparatus described has since been abandoned because the source of heat in the furnace could not be controlled or made flexible.

It was concluded that apparatus, to be entirely satisfactory, should possess the following characteristics:

(1) The furnace or heating medium should be capable of quick adjustment for use at any temperature, from room temperature up to 500°C, and the temperature should be kept constant by automatic control.
(2) The quenching media, whether water or air, should be under control, both as to temperature and to volume.

Such apparatus would be useful for testing vitreous enamels, and also for determining resistance to crazing and quenching for white ware, wall tile, and terra cotta.

II. Description of Apparatus

The apparatus determined upon is an electrically-heated furnace with accessory equipment for temperature control and for holding test specimens. There is also an automatically controlled constant-temperature water bath with equipment for discharging a constant volume stream of water at a constant temperature onto the test piece.

(1) The Furnace In Figs. 1 and 2, *A* consists of a $^1/_2$-inch transite board furnace supported by a $1^1/_4$-by $^3/_{16}$-inch angle iron bolted at the inside corners of the transite. *B* is a sheet-iron casing larger than the furnace. Sil-O-Cel powder is used between this iron casing and

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Enamel Division). Received March 14, 1931.
[2] R. D. Landrum, *Trans. Amer. Ceram. Soc.*, **14**, 489 (1912).
[3] H. Harkort, *ibid.*, **15**, 368 (1913).
[4] C. J. Kinzie, *Jour. Amer. Ceram. Soc.*, **12** [3], 188 (1929).

the furnace for side and end insulation, and the iron casing extending above the top of the furnace permits the use of a layer of Sil-O-Cel powder at the top for additional insulation. *C* represents the electric heating elements, four in number, two at one side and two at the opposite side of the furnace. *D* represents the iron shields one inch from the heating elements, extending from the floor to the ceiling of the furnace, but leaving a space between the ends of the shields and the furnace sides so that the fan can circulate air in the furnace past the coils, the shields serving to prevent the coils from radiating heat directly on the specimens. *E* represents a fan driven by a $^1/_2$-horse power motor at a speed of 1500 r.p.m. *F* is a water-cooled brass bearing. *G* is a graphite bearing placed in the furnace wall, acting as a guide to the fan shaft and to prevent any movement of the fan shaft. *H* is the $^1/_2$-horse power motor, and *I* is the specimen holder.

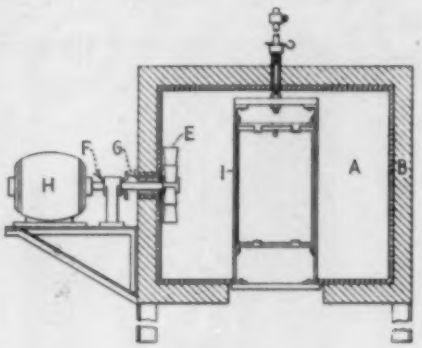

FIG. 1.

(2) The Temperature Controller

Any suitable temperature control may be used. In this apparatus, the air-expansion type is used (see Fig. 3). The end of the glass tube shown outside of the furnace is enlarged to a series of bulbs and the enlarged end contains 50 cubic centimeters of air. As the temperature of the air expands or contracts, due to slight temperature differences, a contact is broken or made in the system of relays which control the current passing through the heating coils of the furnace.

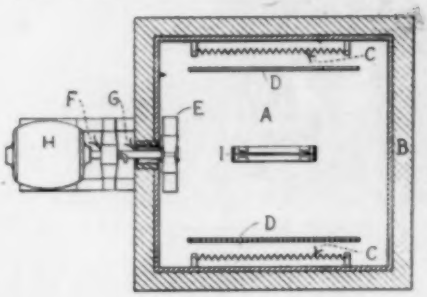

FIG. 2.

The water used in quenching the specimen is kept at 33°C by means of a constant-temperature water supply. This equipment is shown on the shelf in Fig. 3. The tank is of brass outside and contains a smaller tank, plaster of Paris having been poured between the two tanks to form an insulating layer. A friction-drive agitator keeps the water stirred, the motor used to drive the agitator being placed on the shelf at the right of the tank. The temperature is controlled by a Toluene controller working through a bell-ringing

transformer relay operating an ordinary Mazda lamp immersed in the water. The temperature of the water can be kept within $^1/_{10}$°C of the set point. The upper part of the Toluene controller can be seen over the tank suspended from the horizontal bar by means of elastic bands.

The complete assembly of the several pieces of equipment is shown in

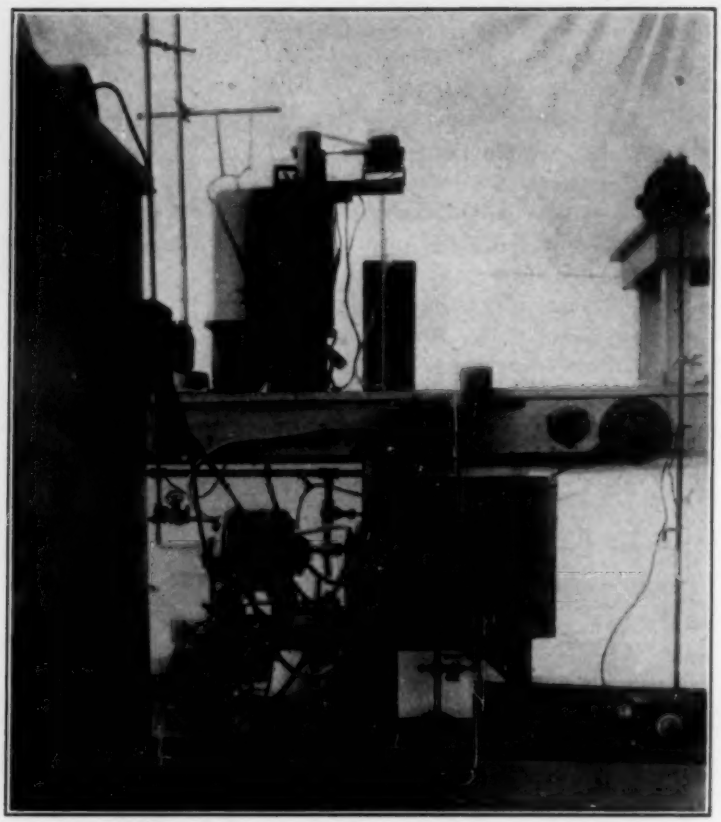

FIG. 3.

Fig. 3. At the left of the furnace is the motor shaft, the water-cooled bearing, and the secondary switchboard. Under the furnace is the specimen holder out of the furnace, but without the test piece to show the position of the stop-cock which is at the end of the water outlet from the constant temperature water bath. At the right of the furnace is the outside part of the glass air-expansion controller and at the lower right hand corner is the bell-ringing transformer. The constant-temperature water bath is shown on the stand in the upper center. The relay switch is at-

tached to the small dark room at the upper right hand corner of the door (ordinarily attached at the side of the dark room but moved so as to show in the photograph).

This furnace has been used to 600°C, which represents the point where the glass bulbs of the controller begin to sag. Somewhat higher temperatures may be used, but the furnace was not designed for use at over 500°C

III. Resistance of Vitreous Enamels to Thermal Shock

The specimen is a 6- by 4-inch iron plate enameled either on one side or both as desired. In the case of pieces enameled on one side only, the specimen, if warped, should be restored to a flat surface by means of a clamping device. Flatware, if warped, is straightened in the mounting process, while cooking-ware enamels do not distort the steel. Thermal shock tests, therefore, should be made on flat pieces so that the enamel may be tested under the existing stress on the flat surface.

The furnace is heated with the specimen holder inside. The holder is then lowered, the test piece placed in the holder, drawn up into the furnace and there held for twenty minutes. One minute before the test piece is to be removed the glass cock is opened and the dead water in the outlet line removed so as to insure a stream of water at 33°C. The holder with its test piece is lowered into the stream of water. The water impinges on the center of the piece and is allowed to flow $^3/_4$ minute. The piece is removed and another test piece is placed in the holder and the cycle is repeated. The water flows at the rate of 312 cubic centimeters per minute.

The procedure used will depend upon the requirements of the case. A furnace temperature of 200°C is good for testing vitreous enamels, but for making a detailed comparison it is advisable to use higher and lower temperatures.

For enamels applied heavy, as on cast iron, lower temperatures should be used first.

No attempt has been made to establish details of a standard thermal shock test. The construction and operating details of equipment should be of value in tests on the thermal-resisting properties of ware, whether it is vitreous enamel on sheet iron or cast iron or whiteware or terra cotta.

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DEVELOPMENT OF LOW-TEMPERATURE ENAMELS ON A FLUORIDE EUTECTIC BASIS[1]

By John F. Hunt and R. M. King

ABSTRACT

Three fluoride eutectics were substituted for cryolite and fluorspar in three standard enamels: sheet-steel ground coat, sheet-steel cover coat, and cast-iron single coat, with a view to lowering their maturing temperature. Substitution in ground coats produced inferior enamels, but no apparent change was evident in cast-iron enamels. In the case of sheet-steel cover coats satisfactory enamels were obtained with a maturing temperature 150°F lower than the original enamel which matured at 1450°F.

I. Introduction

Fluorides are usually added to the enamel batch in the forms of cryolite and fluorspar. The proportions in which these are added are not necessarily constant. Eutectics form in fluoride mixtures as in the case of other compounds. Therefore, it was believed that if the constituents of cryolite and fluorspar were added to the enamel batch in the proportions of a eutectic mixture, the maturing temperature of the enamel would be lowered without any lowering of the quality of the enamel. The use of such enamels should bring about a saving in time and fuel in their smelting and firing.

II. Mode of Procedure

This research is based on the theory of eutectics. In the system NaF–AlF_3 (see Fig. 1) there are two eutectics shown. One consists of 25% AlF_3–75% NaF (by weight), melting at 885°C. The other consists of 63% AlF_3–37% NaF (by weight), melting at 685°C. In the system AlF_3–NaF–CaF_2 (see Fig. 2) there is a eutectic consisting of 60.2% AlF_3–33.6% NaF–6.2% CaF_2, melting at 675°C. There are several eutectics on this diagram, but eutectic "K" was taken because it had the lowest melting temperature.

Cryolite ($3NaF–AlF_3$) consists of 60% NaF–40% AlF_3 (by weight) and melts at 1000°C. It is one of the strongest fluxes used in enamels. The two eutectics in the system NaF–AlF_3 both contain the same constituents as cryolite but in different proportions. The eutectic considered in the system AlF_3–NaF–CaF_2 contains calcium fluoride in addition to sodium and aluminum fluorides, but the percentage of calcium fluoride is low, 6.2% by weight.

Since the three enamels taken for experiment (see Table I) all contained fluorspar, this was taken with the cryolite, and the eutectics substituted in direct proportion to the sum of the cryolite and fluorspar content.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Enamel Division). Received March 14, 1931.

The three eutectics used, "A," "B," and "C," were mixed as shown in Table II and added to the enamel batches as shown in Table III.

Each enamel batch was mixed thoroughly and smelted in a refractory clay crucible in a pot furnace. Fritting was accomplished by pouring the

TABLE I

THREE COMMERCIAL ENAMEL BATCHES

Constituent	Sheet-steel ground (No. 1) (%)	Sheet-steel cover (No. 5) (%)	Cast-iron single (No. 9) (%)
Borax	29.80	32.39	22.68
Feldspar	26.30	34.28	12.80
Quartz	20.30	9.64	12.10
Cryolite	1.95	10.90	5.20
Fluorspar	5.85	4.10	8.65
Soda nitrate	4.75	2.71	3.44
Soda ash	9.40		
Sodium antimonate		6.00	3.44
Cobalt oxide	0.42		
Nickel oxide	0.30		
Manganese dioxide	1.24		
Boric acid			3.44
Barium carbonate			7.59
Zinc oxide			6.81
Red lead			14.05
	100.31	100.02	100.20

molten contents of the crucible into a bucket of water. The frit was then dried and ready for milling in small porcelain ball mills. The enamels were screened and aged for no less than 36 hours before application. The sheet-steel ground coats were applied by dipping, while the sheet-steel cover coats and cast-iron single coats were applied by spraying. The sheet-steel cover coats were applied over ground coat No. 1. All enamels were

TABLE II

EUTECTICS

"A" (%)	"B" (%)	"C" (%)
25 AlF_3	63 AlF_3	60.2 AlF_3
75 NaF	37 NaF	33.6 NaF
		6.2 CaF_2
100 (melting at 885°C)	100 (melting at 685°C)	100.0 (melting at 675°C)

fired in a small electric muffle furnace controlled by a pyrometer. All sheet steel used was cleaned, pickled, and neutralized before dipping. The cast iron was cleaned by a sandblast. For mill additions see Table IV.

(1) Acid Test Used Although neither of the two commercial cover enamels used was in the acid-resisting class, nevertheless an acid test was given enamels Nos. 5 to 12, inclusive, to determine whether the eutectic substitutions in any way increased or decreased

their acid resistance. The acid spot test was used. A circle of paraffin was formed on the surface of the enameled piece and in this space was placed a 7% solution of citric acid for 15 minutes. The attack of the acid was then noted.

TABLE III

PREPARATION AND NOTATION OF ENAMEL BATCHES

	Enamel Number					
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Borax	29.80	29.80	29.80	29.80	32.39	32.39
Feldspar	26.30	26.30	26.30	26.30	34.28	34.28
Quartz	20.30	20.30	20.30	20.30	9.64	9.64
Cryolite	1.95	7.80 Eut. "A"	7.80 Eut. "B"	7.80 Eut. "C"	10.90	15.00 Eut. "A"
Fluorspar	5.85				4.10	
$NaNO_3$	4.75	4.75	4.75	4.75	2.71	2.71
Na_2CO_3	9.40	9.40	9.40	9.40		
Sodium antimonate					6.00	6.00
Co_2O_3	0.42	0.42	0.42	0.42		
Ni_2O_3	0.30	0.30	0.30	0.30		
MnO_2	1.24	1.24	1.24	1.24		

	Enamel Number					
	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12
Borax	32.39	32.39	22.68	22.68	22.68	22.68
Feldspar	34.28	34.28	12.80	12.80	12.80	12.80
Quartz	9.64	9.64	12.10	12.10	12.10	12.10
Cryolite	15.00 Eut. "B"	15.00 Eut. "C"	5.20	13.85 Eut. "A"	13.85 Eut. "B"	13.85 Eut. "C"
Fluorspar			8.65			
$NaNO_3$	2.71	2.71	3.44	3.44	3.44	3.44
Sodium antimonate	6.00	6.00	3.44	3.44	3.44	3.44
Boric acid			3.44	3.44	3.44	3.44
$BaCO_3$			7.59	7.59	7.59	7.59
Zinc oxide			6.81	6.81	6.81	6.81
Red lead			14.05	14.05	14.05	14.05

NOTE: Numerals at top of columns denote enamels. Letters within columns denote eutectics. Nos. 1, 5, and 9 are original enamels.

TABLE IV

	Mill Additions		
Constituent	Sheet-steel ground (%)	Sheet-steel cover (%)	Cast-iron single (%)
Frit	100.0	100.0	100.0
Vallendar clay	7.0	6.0	4.0
Tin oxide		10.0	6.0
$MgCO_3$	0.5		
Borax	0.25		
Water	45.0	45.0	35.0

(2) Fusion Test Used Each milled enamel was dried out and ground in a mortar to pass a 20-mesh screen. Enough water was then mixed with each enamel to make it of a dry-press consistency. They were then pressed into small cylinders $^1/_2$ inch in height and $^1/_2$ inch in diameter. These cylinders were dried and placed in an electric furnace. The heat of the furnace was brought up and the temperature at

which each cylinder assumed a button shape was recorded as the fusion temperature of that respective enamel.

III. Results

(1) Smelting Due to the fact that there was no accurate way of controlling the temperature in the pot furnace and since each enamel batch was not put into the furnace at the same temperature, there was no accurate way of determining the time taken for the smelts. But by taking the above variables into consideration it was estimated that batches Nos. 2, 3, and 4 underwent complete smelting in from $^1/_2$ hour to 1 hour shorter time than batch No. 1.

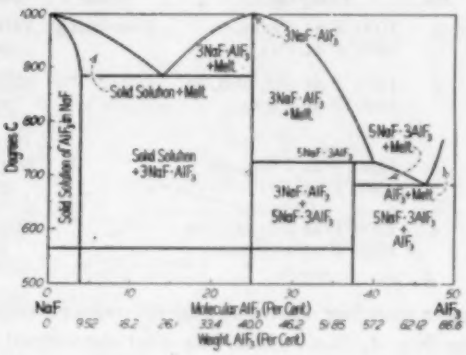

FIG. 1.—The system NaF–AlF_3.

Batches 6, 7, and 8 showed a decrease in smelting time, between 30 and 40 minutes, over batch 5. The colors of the frits of Nos. 6, 7, and 8 were about the same, and showed a great loss of opacity compared to No. 5, which had a good opaque white color.

All the cast-iron batches underwent smelting so rapidly that a difference in time could not be determined. The appearance of batch No. 9 was a pure opaque white, while the appearance of Nos. 10, 11, and 12 were not as white as No. 9, but carried a very light blue tint, showing a loss of opacity in the frit.

(2) Firing The firing results for the four sheet-steel ground coats, four sheet-steel cover coats, and four cast-iron single coats are given in tabular form.

There was not much advantage gained in substituting any of the eutectics for cryolite and fluorspar in the sheet-steel ground coats as they all

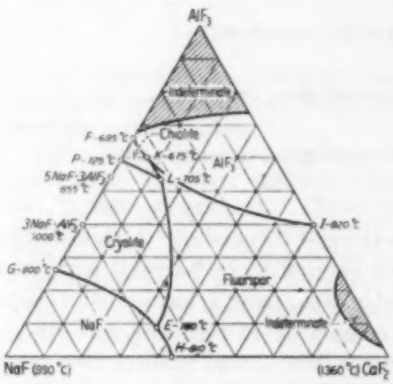

FIG. 2.—The system AlF_3–NaF–CaF_2 (per cent by weight).

Point	NaF	CaF_2	AlF_3
G	73.9		26.1
$3NaF \cdot AlF_3$	60.0		40.0
$5NaF \cdot 3AlF_3$	45.7		54.3
P	40.5		59.5
K	33.6	6.2	60.2
L	32.8	13.7	53.5
H	56.5	43.5	
I		60.0	40.0

Sheet-Steel Ground Coats

Enamel No.	Firing range	Color	Best surface	Defects
1	1500°F at 3 min. to 1550°F at 1½ min.	Blue-black	Velvety, very good	None
2	1450°F at 2½ min. to 1500°F at 2 min.	" "	Slightly rough and pitted	Few copperheads, tendency to fire off edge
3	1450°F at 2 min. to 1500°F at 2½ min.	" "	Slightly rough but good surface	None, but tendency to fire off edge
4	1500°F at 2½ min. to 1600°F at 1½ min.	" "	Slightly rough but good surface	Few copperheads

gave rougher surfaces and introduced copperheads in some cases. Next to No. 1, No. 4 was the best developed ground coat, followed by Nos. 3 and 2.

Sheet-Steel Cover Coats

Enamel No.	Firing range	Opacity	Best surface	Defects
5	1400°F at 4 min. to 1450°F at 3½ min.	Excellent	Good gloss, smooth	None
6	1350°F at 3½ min. to 1400°F at 3 min.	"	Dull but smooth surface	"
7	1300°F at 4 min. to 1350°F at 3½ min.	Good	Extreme gloss, smooth	"
8	1300°F at 4 min. to 1350°F at 3½ min.	"	Extreme gloss, smooth	"

The substitution of eutectics here was very successful. Although the opacity was slightly reduced, it was not enough to be harmful with two coats of enamel. The gloss was increased in Nos. 7 and 8, but was decreased to a dull surface in No. 6. The best enamel developed here was No. 7, although it was very hard to judge between Nos. 7 and 8, since they were both almost perfect.

Cast-Iron Single Coats

Enamel No.	Firing range	Opacity	Best surface	Defects
9	1300°F at 10 min. to 1400°F at 6 min.	Good	Good gloss, smooth	Slight pinholing
10	1350°F at 7 min. to 1400°F at 5 min.	"	" " "	" "
11	1300°F at 10 min. to 1400°F at 5 min.	"	" " "	" "
12	1300°F at 10 min. to 1400°F at 5 min.	"	" " "	" "

There was no change at all noticed in the appearance of the cast-iron enamels. They all showed slight pinholing with about the same luster and opacity. No advantage was seen in substituting the eutectics for cryolite and fluorspar in this commercial cast-iron enamel.

(3) Acid Test This test showed that acid resistance was not influenced by the substitution of eutectics in these enamels for the fluorides.

(4) Fusion Test In the fusion test, the cylinder of Enamel No. 1 assumed button shape at 1350°F, No. 2 at 1340°F, Nos. 3, 4, 7, and 8 at 1320°F, Nos. 5 and 6 at 1360°F, and Nos. 9, 10, 11, and 12 at 1300°F.

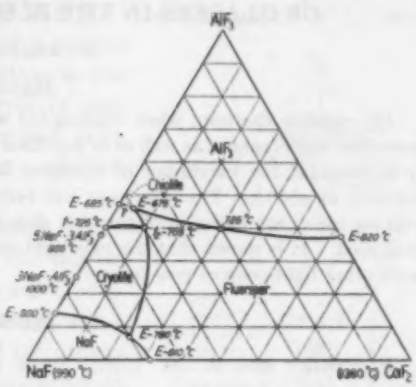

FIG. 3.—The system AlF_3–NaF–CaF_2 (molecular per cent). (Taken from International Critical Tables, Vol. IV, p. 81.)

IV. Conclusions

(1) With the sheet-steel ground coat used in this research, no successful enamel of lower maturing temperature or time was developed by any of the eutectic substitutions.

(2) With the sheet-steel cover coat, two successful enamels, No. 7 and No. 8, of lower maturing temperature than the commercial enamel No. 5, were developed. These two successful enamels contained the eutectics "B" and "C," respectively, and one was about as good as the other. The maturing temperature was lowered 150°F (from 1450° to 1300°) by each eutectic and would be worth considering commercially.

(3) With the cast-iron single coat, no successful enamel of lower maturing temperature or time was developed by any of the eutectic substitutions. The commercial enamel and the three eutectic enamels all showed about the same surface and same maturing temperature and time.

(4) The best working eutectic was "B" (63% AlF_3, 37% NaF, melting at 685°C).

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ON A NEW LIGHT-SOURCE FOR ABSORPTION MEASUREMENTS OF GLASSES IN THE BLUE AND ULTRA-VIOLET[1]

By Willi M. Cohn

ABSTRACT

On metallic thorium, when bombarded with cathode rays, a blue glow may be observed in high-vacuum as well as in gas-filled tubes. The spectrum of this phenomenon is continuous, the maximum of intensity being (according to photographic determinations) at 4500Å. The spectrum has been observed from 6000 to 2200Å. Lamps making use of the emission of the blue glow on thorium are described and their spectra discussed. It is shown that the new light-source has several advantages in comparison with other light-sources now in use.

I. Introduction

F. Rother and W. M. Cohn[2] have shown that in a high vacuum a glow of a characteristic blue color is observed when (under certain conditions) the radioactive metal thorium is bombarded with cathode rays (electrons). Detailed descriptions and the theory of this phenomenon are given in several papers by W. M. Cohn.[3]

The spectrum of the blue glow is continuous and extends far into the ultra-violet region of the spectrum. It is shown that the blue glow may be used as a light-source for spectroscopic investigations. A short description is given of the thorium-lamps developed and the spectra emitted. No details are given here of the phenomena observed or the theory thereof, but only a discussion of the practical value of the lamps for absorption measurements of glasses.

II. Thorium Lamps

Originally, the blue glow on thorium was observed in a high vacuum only. Subsequently it has been found possible to obtain the same phenomenon in the presence of gases (even in air) under certain conditions, when thorium is bombarded with cathode rays. The most convenient working conditions are present in a tube with a low vacuum, *i.e.*, 0.5 to 5×10^{-3} mm. Hg. Electrons are generated by the impact of the cathode by ions in the same way as in gas-filled X-ray tubes.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Glass Division). Received March 17, 1931.

[2] F. Rother und W. M. Cohn, "Über das Auftreten eines kontinuierlichen Spektrums im Blauen und Ultravioletten an Metalloberflächen," *Naturwissenschaften*, **18**, 155–56 (1930).

[3] (*a*) W. M. Cohn, Über das Auftreten von kontinuierlichen Spektren bei Kathodenstrahlbombardement. I. Vorbemerkungen, *Z. Physik*, **70**, 662–66 (1931).
(*b*) *Ibid.*, II. Aeonaeffekt, *ibid.*, 667–78.
(*c*) *Ibid.*, III. Thorium im Hochvakuum, *ibid.*, 679–94.
(*d*) *Ibid.*, IV. Untersuchungen an Thorium und anderen Substanzen in Gegenwart von Gasen. In press.
(*e*) *Ibid.*, VII. Theoretische Erwägungen. To appear later.

Figure 1 shows a schematic view of a thorium lamp as developed for spectrographic investigations. The disk of thorium metal ($^9/_{16}$ inch diameter, $^1/_{16}$ inch thick) is fixed on a copper rod which can be water-cooled and serves as the anode. The concave aluminum mirror is used as the cathode. Above the cathode is a mica shield. A tube with a quartz glass window serves for observations.

The thorium lamp can be operated either by evacuating and sealing off from the pumps or in continuous connection through a mercury trap with the pumps. In the first instance the pressure inside the lamp is regulated by means of a palladium tube and cathode sputtering of a fine wire or the like (*cf.*, the gas-filled X-ray tubes), while in the second instance, regulation of pressure is effected by means of a needle valve.

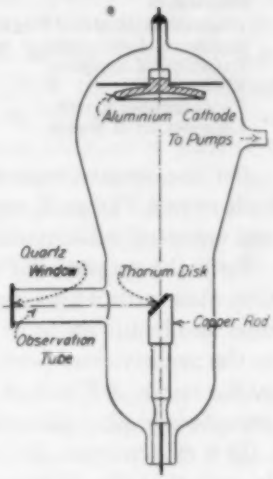

FIG. 1.—Thorium lamp.

III. Spectrum Emitted

If a rectified voltage of 2500 $v._{max.}$ is applied between the cathode and anode, a blue glow is observed on the thorium metal, even when a current of only 1 mÅ flows through the lamp. As is shown in the publications,[3] the spectrum of the blue glow on thorium is observed from 2200 to 6000Å with sufficient intensity. The maximum intensity is found photographically at 4500Å.

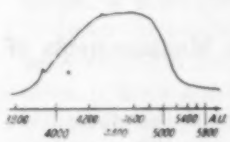

FIG. 2.—Microphotometer curve of the spectrum of the blue glow on thorium; glass spectrograph.

The distribution of energy from the continuous spectrum of the blue glow is shown in Figs. 2 and 3. The curves were taken by a self-registering Goos-Koch microphotometer[4] from spectra obtained with glass and quartz spectrographs, respectively. The abscissas of the curves are wave-lengths, the ordinates, intensities in an arbitrary scale. The width of the slit of the microphotometer as related to the plane of the photographic plate was 0.03 mm. and 2 mm. high. The conditions of the spectrographic exposures were as follows:

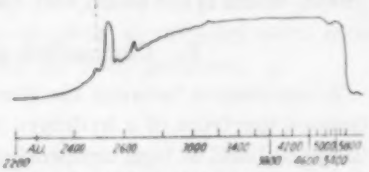

FIG. 3.—Microphotometer curve of the spectrum of the blue glow on thorium; quartz spectrograph.

[4] F. Goos und P. P. Koch, "Uber eine Neukonstruktion des registrierenden Mikrophotometers," *Z. Physik*, **44**, 855–59 (1927).

SPECTROGRAPHS

	Glass	Quartz
Spectrograph made by	Fuess (Berlin)	Fuess (Berlin)
Dispersion	20Å/mm.	17Å/mm.
Dispersion at wave-length	3900Å	2500Å
Aperture of objective of camera used	1 : 10	1 : 7.5
Duration of exposure	90 min.	24 min.
Width of slit	0.1 mm.	0.1 mm.
Photographic plates	Hauff extra-rapid	Hauff-Flavin
Dimensions of plates	$2^{9}/_{16} \times 3^{17}/_{32}$ in.	$3^{15}/_{16} \times 5^{29}/_{32}$

For the spectra reproduced here, a thorium lamp was used which was built from a Philips X-ray tube. It was provided with a cooled anode and was operated while connected to the vacuum pumps.

Both the spectra of Figs. 2 and 3 show the continuous spectrum of the blue glow with its maximum of intensity at 4500Å. Furthermore, a few lines and bands are to be seen which can be identified as mercury lines and as the negative and positive groups of the nitrogen bands. The minimum in the curve of Fig. 3 at 5200Å is caused by a minimum of sensibility of the photographic plate in this region of the spectrum.

It is evident that the continuous spectrum goes far into the ultra-violet. In case that the shortest wave-lengths of the spectrum are of no interest for the investigations planned, the quartz window of the thorium lamp may be replaced by a glass window.

IV. Application of New Light-Source to Absorption Measurements of Glasses

In a paper by W. M. Cohn and C. Andresen-Kraft[5] the absorption behavior of some FeO and Fe_2O_3 glasses is studied when different light-sources are applied. From the curves given it is seen that the glasses cut off the short wave-lengths of the spectra. The sharp limit of the spectra is of special interest being characteristic for all glasses containing iron.

With the Fe_2O_3 glasses a minimum of transmission is observed at about 3800Å, which is not found with the FeO glasses.

V. Comparison of Different Light-Sources

A comparison between the spectrum of the new thorium lamp, the continuous spectrum of a hydrogen tube, and the spectrum of a lamp with a tungsten band at high temperature is given by Cohn and Andresen-Kraft.[5]

The advantage of the thorium lamp over the hydrogen tube as a source of continuous spectrum is found in the fact that lines or bands at longer wave-lengths are absent in the thorium lamps.

A characteristic feature of the thorium lamp in comparison to the tung-

[5] W. M. Cohn und C. Andresen-Kraft, "Über Absorptionsmessungen an Gläsern mit Thoriumlampe, Uviollampe, und Wasserstoffkontinuum," *Z. tech. Phys.*, **12**, 428–33 (1931).

sten band lamp is the fact that the long-wave emission is very weak. With tungsten band lamps generally, over-exposure will occur at long wave-lengths when the short wave-lengths of the spectrum are properly exposed for absorption and other measurements. Thus with band lamps it is necessary to make use of special filters or to expose different regions of the spectrum for different t me intervals. With the thorium lamp, the whole spectrum of a glass can be received on one plate with a convenient distribution of energy throughout the entire range of the spectrum.

Another advantage of the thorium lamps is their low temperature. They may be designated as "cold light sources." Temperature effects on the spectral transmission of glasses to be studied as observed with other light-sources emitting long-wave spectra (*cf.*, Nitchie and Schmutz[6] and Weizel and Wolff[7]) are not to be found with the thorium lamps.

VI. Summary

A new light-source for absorption measurements of glasses in the blue and ultra-violet parts of the spectrum is described. The lamp is based on the phenomenon that on metallic thorium, when bombarded with cathode rays under certain conditions, a blue glow is observed.

Thorium lamps may be operated in closed form, *i.e.*, in the way of usual lamps, or in an open form, *i.e.*, under constant evacuation.

Under the conditions depicted, the spectrum of these lamps is continuous between 2200Å and 6000Å at least. According to photographic determinations, it has a maximum of intensity at 4500Å.

The emission of the blue glow on thorium starts on application of very small energy input.

A disadvantage of the thorium lamp is the relatively small intensity. In most cases, however, it is sufficient for visual and photographic investigations. (By certain changes in the arrangement of the anode it will be possible to apply more energy and to raise the intensity of the lamp.)

The new light-source possesses some marked advantages over other lamps now in use which may recommend it for many purposes.

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[6] C. C. Nitchie and F. C. Schmutz, "Transmission Changes in Ultra-Violet Glasses During High-Temperature Exposure to Light," *Science*, **71**, 590 (1930).

[7] W. Weizel und H. W. Wolff, "Über die Temperaturabhängigkeit des Absorptionsvermögens einiger Gläser im Ultraviolett," *Z. tech. Phys.*, **11**, 358–61 (1930).

THE DIELECTRIC STRENGTH OF PORCELAIN: THE INFLUENCE OF FIRING TEMPERATURE[1]

By A. J. Monack, L. R. Shardlow, and D. H. Wamsley

ABSTRACT

This paper completes the work previously reported by Monack and Shardlow.[2] The additional puncture voltages in kilovolts per quarter-inch thickness were cone 13, 60; cone 14, 69.5; cone 15, 67. The puncture voltage increased gradually between cones 9 and 15. Other conditions remaining identical, it was shown that the most uniform body resulted when fired to cone 9.

I. Introduction

Most of the published data on the dielectric strength of porcelain are open to criticism because an insufficient number of samples was used, hence this investigation of dielectric strength of porcelains fired to cones 7 to 15. A preliminary paper[2] summarized the results of tests on porcelain fired to cones 7 to 12. This paper completes the investigation and the results of the entire project are analyzed.

TABLE I

EXPERIMENTAL DATA ON DIELECTRIC STRENGTH

Sample No.	Kilovolts to puncture	Thickness* (inch)	Kilovolts per ¼ inch	Sample No.	Kilovolts to puncture	Thickness* (inch)	Kilovolts per ¼ inch	Sample No.	Kilovolts to puncture	Thickness* (inch)	Kilovolts per ¼ inch
13–1	56.5	0.215	66.0	14–1	61.0	0.236	64.5	15–1	61.0	0.242	63.0
13–2	44.5	0.225	49.5	14–2	68.0	0.237	72.0	15–2	55.0	0.246	56.0
13–3	52.5	0.226	58.0	14–3	62.0	0.236	66.0	15–3	55.0	0.225	61.0
13–4	36.0	0.249	36.0	14–4	62.5	0.237	66.0	15–4	74.5	0.240	77.5
13–5	47.0	0.218	54.0	14–5	71.0	0.230	77.0	15–5	61.5	0.238	65.0
13–6	53.0	0.225	59.0	14–6	64.5	0.244	66.0	15–6	37.0	0.263	35.0
13–7	57.0	0.231	61.5	14–7	61.0	0.237	64.5	15–7	67.0	0.247	68.0
13–8	57.0	0.226	63.0	14–8	72.0	0.231	78.0	15–8	65.5	0.226	72.5
13–9	57.0	0.239	59.5	14–9	61.0	0.231	66.0	15–9	56.0	0.245	57.0
13–10	71.5	0.237	75.5	14–10	61.5	0.233	66.0	15–11	55.5	0.248	56.0
13–11	66.0	0.238	68.5	14–11	68.0	0.262	65.0	15–12	81.5	0.231	88.5
13–12	62.0	0.233	67.0	14–12	62.0	0.232	67.0	15–13	73.0	0.253	72.0
13–13	66.0	0.240	69.0	14–13	77.0	0.219	88.0	15–14	68.0	0.234	72.5
13–14	67.0	0.237	70.5	14–14	65.0	0.220	74.0	15–17	69.5	0.259	67.0
13–15	56.5	0.241	59.0	14–15	70.0	0.235	74.5	15–18	65.5	0.229	71.5
13–16	63.0	0.234	67.5	14–16	68.0	0.239	71.0	15–19	71.0	0.245	72.5
13–17	45.0	0.224	50.0	14–17	66.0	0.242	68.0	15–20	73.0	0.255	71.5
13–18	57.0	0.242	59.0	14–18	63.0	0.244	64.5	15–21	72.5	0.245	74.0
13–19	56.0	0.225	62.0	14–19	69.0	0.240	72.0				
13–20	37.0	0.206	45.0	14–20	69.0	0.232	74.5				
13–21	58.0	0.225	64.5	14–21	47.0	0.225	52.0				

* Mean of 5 measurements near the puncture.

[1] Received December 4, 1931.

[2] *Jour. Amer. Ceram. Soc.*, **14** [9], 603–607 (1931).

II. Discussion of Results

The data obtained for cones 13, 14, and 15 are given in Table I. The summarized data for cones 7 to 15 are given in Table II and shown in Fig. 1.

The specimens were fired as high as cone 15 in the hope that a vesicular structure might develop at that temperature. Such, however, was not the case and the apparent porosity remained zero even at cone 15. A decrease in bulk specific gravity after cone 11 occurred and this may be considered as a sign of overfiring.

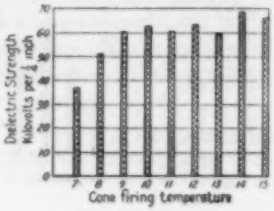

FIG. 1.—The mean dielectric strengths of samples fired to different cone temperatures.

It has been customary to plot various properties as a function of the cone firing temperature. In the previous paper[2] this was done. Such a procedure does not seem to be justifiable when it is considered that the cone temperature is not an absolute unit. Consequently, in this paper, vertical bar charts have been used to express graphically the results obtained.

TABLE II

SUMMARY OF ANALYSIS OF EXPERIMENTAL DATA

Series	No. of samples	$\bar{X}$	σ	p. e.	P. E.	C (%)	Actual % P. E.	% P.E. calculated on basis of 20 samples
7	18	37	5.5	3.7	0.92	15	2.5	2.4
8	20	51	5.3	3.6	0.86	11	1.7	1.7
9	20	60.5	4.4	3.0	0.71	7	1.2	1.2
10	19	63	5.5	3.7	0.89	9	1.4	1.4
11	20	61	6.2	4.2	1.0	10	1.6	1.6
12	20	64	6.8	4.6	1.1	11	1.7	1.7
13	21	60	9.1	6.1	1.4	15	2.3	2.4
14	21	69.5	7.0	4.7	1.1	10	1.6	1.6
15	18	67	11.2	7.6	1.9	17	2.8	2.7

$\bar{X}$ = arithmetic mean
σ = standard deviation
p. e. = probable error of a single observation = $0.6745\,\sigma$
P. E. = probable error of the arithmetic mean (calculated by Student's Small Sample Theory)

$$C = \text{coefficient of variability} = \frac{\sigma}{\bar{X}} \times 100$$

$$\%P.\,E. = \frac{P.\,E.}{\bar{X}} \times 100$$

(For definitions of the statistical terms used above see Handbook of Mathematical Statistics, H. L. Rietz, Editor-in-Chief, Houghton Mifflin Company, New York, 1924.)

Examination of Fig. 1 shows that the dielectric strength increased with cone firing temperature in the range covered. There is no absolutely definite relation but the tendency, shown in Fig. 1, is very pronounced. Suf-

ficient samples were used at each cone temperature so that the mean values obtained are reliable.

As is well known, the arithmetic means of any measurements are not useful unless some measure of the dispersion about the mean is given also. Figure 2 shows the standard deviations[3] to correspond with the arithmetic means of Fig. 1. It is evident that with the exception of the cone 14 series the relationship is very regular.

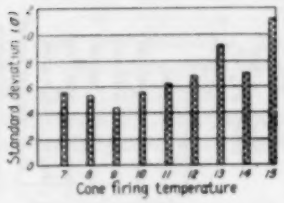

FIG. 2.—The standard deviations of samples fired to different cone temperatures.

From Fig. 2, it is safe to conclude that for electrical porcelain there is a firing temperature which results in the most uniform body when considered from the viewpoint of dielectric strength. For the porcelain used in this work, cone 9 firing resulted in the most uniform body. On either side of this temperature the dispersion increased.

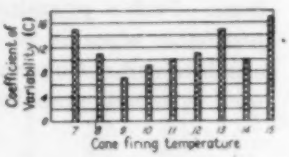

FIG. 3.—The coefficients of variability of samples fired to different cone temperatures.

The coefficient of variability, shown in Fig. 3, is a better measure of dispersion because it takes into account differences in the arithmetic means. With the exception of the cone 14 series, the resulting relationship verifies the conclusion drawn from Fig. 2.

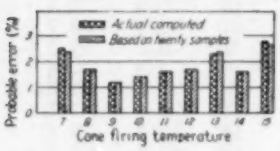

FIG. 4.—Per cent probable errors of the means of samples fired to different cone temperatures.

The per cent probable error is merely the probable error[3] expressed as a percentage of the arithmetic mean. Figure 4 shows that this statistical constant follows the same trend as the standard deviation (Fig. 2) and the coefficient of variability (Fig. 3). Since the value of the probable error is dependent upon the number of samples used, Fig. 4 represents not only the actual computed probable errors but also the probable errors based on twenty samples. The differences are small.

III. Summary

(1) The puncture voltage was found to increase rapidly in the firing temperature range between cones 7 and 9; between cones 9 and 15 the increase was more gradual.

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[3] For definition see A. E. R. Westman, *Jour. Amer. Ceram. Soc.*, **10** [3], 133–47 (1927).

(2) The standard deviation, the coefficient of variability, and the per cent probable error of the mean showed minimum values at cone 9 and indicated that the most uniform body, electrically, was obtained at this firing temperature.

(3) The variations in any property with respect to firing temperatures and the determination of the temperature at which the most uniform body results (as shown by statistical measures of dispersion) offer a means of showing the temperature to which electrical porcelain (or other ceramic materials) should be fired.

Acknowledgment The authors wish to acknowledge the aid of J. O. Kraehenbuehl, Electrical Engineering Department, and to express their appreciation to C. W. Parmelee, Head of the Department of Ceramic Engineering, for permission to publish this paper.

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NOTES ON CASTING SLIP IN PRODUCTION[1]

By George A. Wills

ABSTRACT

The conclusions regarding eleven properties of a casting slip as to their influence on the loss record of shop and kiln are given. A description of the test is given with each conclusion when the standard test was not used. A list of properties for a daily record of the character of a casting slip is given.

I. Introduction

A complete résumé of the literature on casting of clayware has been presented by F. P. Hall, together with some of his observations.[2] W. L. Sample has also given some notes on the behavior of a casting slip in production.[3]

The present paper is of the nature of the latter publication and states briefly the impressions gained from a daily test of slip in production during the year ending February, 1930.

The sample for test was taken in the casting shop daily. The properties were plotted and their trends were compared with the casting shop and biscuit kiln losses. The records of each week were separated and it was noted whether the majority of weeks showed the property in question running parallel or perpendicular to the loss curve.

II. Tests

(1) Sodium Silicate The specific gravity of sodium silicate was obtained by weighing 100 cubic centimeters. This varied from 1.29 to 1.31, with an average of 1.30. The ratio of soda to silica was approximately 1 to 4. There was no relation between this variable and the loss-curve variations.

(2) Temperature of Slip The temperature of the slip varied from 23 to 29°C. There was no pronounced relation owing, no doubt, to the fact that the slip comes to the same temperature in the mold before draining each day's cast.

(3) Viscosity The viscosity of the slip was obtained by noting the time for 100 cubic centimeters of slip to flow from a tube viscosimeter made of $1^1/_2$- by $6^1/_2$-inch standard brass pipe with an orifice in the bottom $^5/_{32}$ inch in diameter by $^{11}/_{32}$ inch long. The viscosimeter was used without top.

NOTE: It required 68.2 seconds for 100 cubic centimeters of glycerine at 23°C to flow out of this viscosimeter. The glycerine had a specific gravity of 1.25. The time for a sugar-water solution of the same specific gravity was 8.0 seconds and the temperature was 21.5°C.

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Received March 26, 1931.

[2] F. P. Hall, *Jour. Amer. Ceram. Soc.*, **13** [10], 751–66 (1930).

[3] W. L. Sample, *ibid.*, **13** [11], 874–75 (1930).

The normal range of the slip was 40 to 50 seconds. The flow dropped to 36 seconds in a few days with increase in loss. When it reached 60 seconds losses began to increase.

(4) Specific Gravity of Slip This was obtained by weighing 100 cubic centimeters of the slip. The range was from 1.78 to 1.81. There was no influence exerted on the loss curve in this range.

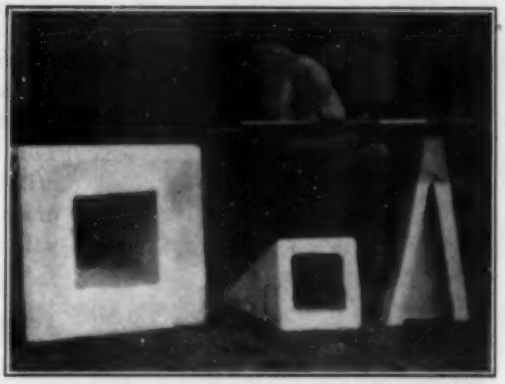

FIG. 1.

(5) Casting Rate The casting rate was obtained by making a 2-hour drain cast of a hollow wedge as shown in Fig. 1. The wedge shown is 3 inches square by 7 inches high. The mold is filled with the slip, allowed to stand two hours, then turned on its side and allowed to drain. As soon as possible the wedge is removed and allowed to become leather hard when cut in two. Figure 1 also shows where the measurements were made after the casting had become dry. The mold with which this test is made is kept exposed to the atmosphere of the room in which the room temperature and relative humidity measurements were taken.

FIG. 2.

This measurement ranged from 27 to 31 millimeters, 29 millimeters being the average. A sudden increase in casting rate will entail high losses in the drain cast ware, but a sudden decrease will not have this effect because the slip can stand until it casts to the desired thickness. If the casting rate drops below 25 millimeters, however, the same loss occurs since the cast nearly

reaches its maximum thickness in about 2 hours and will not cast up much thicker even though it is left in the mold considerably longer.

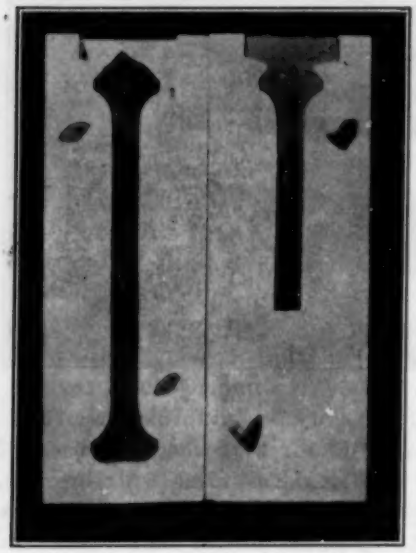

FIG. 3.

(6) Drain In determining the casting rate, the thicknesses of the top and bottom walls of the wedge were taken and their difference calculated (see Fig. 2). This was found to be normally 0.5 millimeter and was called the drain. There was no relation with the losses.

(7) Room Temperature The room temperature varied from 70 to 83°F. There was no relation with the losses.

(8) Plasticity Plasticity was obtained by making the casts shown in Fig. 3 (which shows them just before the cast began to turn white). Each cast has a 10-centimeter distance laid off on it. The difference (usually 1.0 millimeter) between these distances was determined after the casts had dried in the mold. The one confined at both ends had, of course, broken when its water of plasticity left it. The bars are $^1/_2$-inch square in cross-section.

There was no pronounced relation, although it seemed that the tendency was to establish an inverse relation with the loss curve. The shrinkage of a body is not great enough to make this a sufficiently sensitive test for bodies.

FIG. 4.

(9) Shrinkage The shrinkage was obtained by getting the linear shrinkage from the mold size on a 1-inch bar (see Fig. 4). The dry shrinkage was 3.5% and the total shrinkage was 12.5%. There was no appreciable variation throughout the whole year so the conclusion is that there was no influence of this property on the loss curve.

(10) Relative Humidity This was obtained by the use of a sling type wet- and dry-bulb hygrometer. The range was 26 to 64% with the average near 45%. Low losses were found at both extremes.

(11) Warpage in Kiln The warpage in the kiln was obtained by getting the difference between the end measurement and the fork measurement on the trial shown in Fig. 4. This trial was marked in the bone dry state, the distance then being 25 millimeters.

The warpage ranged between 7.0 and 8.3 millimeters, with best results occurring between 7.5 to 8.0 millimeters. This fire corresponded to cone 11, the tip just touching the plaque.

III. Conclusion

A daily record consisting of the following points should be kept if control of a casting slip is to be attained: (1) casting rate, (2) viscosity of slip at a standard temperature, *i.e.*, 20°C, (3) specific gravity of the slip, (4) if a standard temperature is not adopted, then the temperature of the slip should be taken; but it is desirable to use a standard temperature, and (5) an absorption and warpage test should be made.

FIG. 5.

The casting rate may be measured by making a cast of a cone $2^1/_4$ inches in diameter and 5 inches high (see Fig. 5). The mold is kept level full of slip for 30 minutes, then drained into a 100-cubic centimeter graduate. When the drain is complete the cubic centimeters of slip which have been poured into the graduated cylinder are noted. The cast should be removed from the mold as soon as possible, placed in a drier, and weighed when bone dry. It should then be broken and the thickness measured. This gives the casting rate in three units, each serving as a check on the other.

The mold used in making this casting-rate test should be kept in a room where the temperature and humidity do not undergo very violent changes. This condition would be attained if the room was heated and not closed from the outdoors. A good arrangement would be to keep the mold and a pan of water sealed in the same container. It may be desirable to keep the test mold in the casting shop so that gradual changes, at least, may be taken care of in the adjustment of the slip. The primary object of this paper, however, is to call attention to the variables which have a clear relation to the production of ware made from a casting slip and not to specify exact methods of measurements.

The time and dimensions used in this test were for a vitrified sanitary-ware body. It may be that other values would be more convenient if another body was under test.

The test cast should be kept and when the ware cast on the same date enters the kiln it can be placed with this ware to serve as a sample for an absorption test when the firing process is complete. It may be that the absorption trial can best be made separately by means of a solid cast to a thickness which corresponds to the average thickness of the ware being produced.

ELJER COMPANY
FORD CITY, PA.

A TRIAL FOR TESTING CLAY BODIES AND BODY MATERIALS ON A LABORATORY SCALE[1]

By George A. Wills

ABSTRACT

A body trial is described which can be used to investigate, in the laboratory, the commercial possibilities of the members of a series of bodies, a given body, and the kind of materials to be used in a body. Some examples of its uses are given.

I. Introduction

The investigation of blends and materials for clay bodies may be pursued in either of two ways. The experiments may be carried out on a semi-commercial scale in which ware is made from the experimental blends in the same way that it is made in the factory. This may involve the use of equipment necessary to handle a batch of a ton or more. The product of such a miniature plant is then tested in some manner or judged by the eye to ascertain whether the blend in question is practical or not. Again the experiments may be carried out on a laboratory scale in which a trial or test piece is made from the experimental blends and measurements or tests made on these trials. The data thus obtained are used to judge the commercial possibilities of the blends. This method should not demand a batch of more than 1000 grams. The following is a description of a trial which, it is believed, has met this need.

II. Specifications

To be of value to the laboratory a body trial should embody the following points:

(1) The weight of the trial should be small to facilitate the investigation of a field consisting of several members, or the testing of several different samples of one or more materials.

(2) The forming of the trial should be sufficiently difficult to give advance information of what problems would be encountered in the shop if a particular blend is used. Yet it should not be too difficult to form, so that the boundary members of a promising field cannot be investigated.

(3) It should consume no more time to get the data from the trial than is required to produce a piece of fired ware from the raw materials in the factory.

(4) The forming and firing of the trial should give data which can be recorded in numbers representing some standard unit of measurement or a ratio of such numbers.

(5) The accuracy or variation in the values given by such data should meet the requirements of the American Ceramic Society Standard Tests.

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Received March 26, 1931.

III. History

The firing of a 1/2- by 1- by 9-inch beam supported by refractory knife edges 7 inches apart has not been productive of reliable data, owing to the friction at the knife edges which tended to suspend the bar while being fired as though it were a cable, and also owing to the twisting of the bars when the firing shrinkage took place. It is evident that the indicator of warpage must be cast integral with the supporting portion. A flat U-bar was tried with 1- by 1- by 6-inch prongs, the prongs being 1 inch apart at the inside faces. Two trials were made, one with the bend of the U 1 inch thick and another, 1/2 inch thick. Two trials with these dimensions, except that the upper prong was 3 inches instead of 6 inches, were also made. Difficulty was encountered by cracking in the bend of the U. It was also believed that a trial of less weight could be devised.

A 45-degree Y-bar was given a test. Two trials of this type were made, one with a 1-inch indicator beam and one with a 1/2-inch indicator beam. Both were 1 inch wide. This Y-bar was an improvement but unsatisfactory, owing to an incomplete cast at the fork. These trials yielded the information that other things being equal, warpage was close to being inversely proportional to the thickness of the supporting wall. The figures on the 1-inch and 1/2-inch indicator were 3.7 millimeters and 8.1 millimeters, respectively, which is within 10% of the 2 to 1 ratio.

By this time it was evident that the trial should consist of two parts: A 1-inch square section to impose the forming requirement as well as to meet the American Ceramic Society standard shrinkage test; and a 1/2-inch square or 1/2- by 1-inch section to give the warpage data.

IV. Description

Figure 1, from left to right, shows the progressive steps which were taken in developing the trial on the right which was adopted as the standard. They are all solid castings, 1 inch thick from front to back, except the third from the right which is cut from a drain cast hollow wedge.[2] The dry weights of the batches required to form these trials are (reading from left to right) approximately 415, 390, 350, 310, 310, 800, 260, and 210 grams, respectively. Figure 2 shows a close-up view of the trial on the right in Fig. 1. This was the trial which was adopted for use as the standard. The trial is cast in a two-part mold and the end cut off when leather hard. The two parts are then fired in the position and to the cones shown in the figure.

FIG. 1.

[2] See Fig. 1, p. 136, this issue

A body to be tested is mixed, formed, and fired in parallel with the standard body. Three trials of each are enough to give the comparative information. If a material, china clay for example, is to be tested, a slip is made of flint, feldspar, and ball clay. This slip is divided into two equal parts and the standard china clay is added to one while the china clay to be tested is added to the other. Three trials are formed of each batch and the data on both are collected.

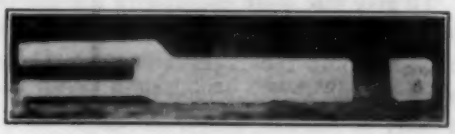

FIG. 2.

The standards used are usually the clays, flint, and feldspar, whose behavior in the shop, where the tested material will be used, is known. Because the manner of collecting all of this data, except the warpage, is similar to the methods described in the American Ceramic Society standard test specifications, this paper will deal only with the warpage measurement.

V. Warpage

The drying warpage is obtained by measuring, in the dry state, the distance in millimeters between the prongs at the fork and at the ends, then subtracting the end measurement from the measurement at the fork and prefixing the proper algebraic sign. The trial is then marked with lines 25 millimeters apart and fired in the upright position. The end measurement is subtracted from the fork measurement. This gives the firing warpage. If greater accuracy is desired the value might be corrected to a standard shrinkage but this is not required in usual practice.

VI. Uses

All of the uses given here relate to casting slip but there is no apparent reason why this trial could not be used on pressing bodies as well as casting batches. The principal use to which this trial was put was a daily test of the body in production. It was adopted for that purpose in August, 1929, and used until the test was completed the last of the following February. By these tests a maximum and minimum warpage was found which corresponded with the proper fire for that particular body.

Other uses that have been made of it are more of a laboratory nature. As a result of such investigations it was found that a short body would give a negative dry warpage, *i.e.*, the prongs would spread; and that in the event the body was too plastic or was not sufficiently deflocculated, there would be a positive drying warpage, *i.e.*, the prongs would come together. If they remained parallel the body was well balanced as to its plasticity and extent of deflocculation.

A firing warpage survey showed that ball clay and flint were the low-

warpage materials, while china clay and feldspar were the high warpage materials. In a body fired to cone 10 from 50 to 60% of the warpage takes place by the time cone 7 is reached. A decrease from 32 to 27% in feldspar content causes an 8% decrease in warpage. A decrease from 50 to 40% in clay content causes a 22% increase in warpage.

To give one more example of the use of this trial, results of a test of 16 feldspars will be cited. A large batch of slip was made of ball clay, china clay, and flint. This slip was divided into sixteen equal parts and a sample of each feldspar was added to each one of these parts so that the result was a body of the following formula:

Material	(%)
Standard ball clay	22.5
Standard china clay	22.5
Standard flint	22.5
Feldspar to be tested	32.5
	100.0

Classification of the feldspars according to their firing range consisted in multiplying the absorption at cone 7 by the vitrification warpage at cone 10. This vitrification warpage was obtained by prefiring the trial in the flat position, getting the warpage due to shrinkage, then refiring it in the upright

FELDSPAR TEST RESULTS

Laboratory No. of feldspar	Rating	Absorption cone 7 (A) (%)	Vitrification warpage (vw) (mm.)	Firing range Ax VW = FR	Av. FR	Grade
2	1	3.9	0.5	2.0		
1	2	4.4	0.5	2.2	2.1	A
12	3	2.5	1.8	4.5		
13	4	3.6	1.3	4.7		
16	5	3.0	1.8	5.4		
10	6	3.2	1.7	5.4	5.0	B
3	7	3.6	1.8	6.5		
8	8	3.9	1.7	6.6		
9	9	4.1	1.6	6.6		
15	10	3.8	1.8	6.8		
5	11	4.6	1.5	6.9		
11	12	5.6	1.3	7.3	6.8	C
14	13	1.7	4.4	7.5		
4	14	2.4	3.8	9.1		
6	15	5.4	1.9	10.2		
7	16	2.6	4.7	12.2	9.8	F*

* Feldspars in this grade flocculate the slip which was deflocculated by sodium silicate.

position and getting this warpage. The first value obtained was subtracted from the second giving the warpage due to the feldspar softened by the fire. It is interesting to note that this vitrification warpage amounted only from 10 to 20% of the total firing warpage, *i.e.*, the warpage occurring when the trial was fired from the dry to the vitrified states in the upright position.

VII. Accuracy

Using the data obtained in the feldspar test, the accuracy of this warpage test was calculated to be 12% average variation from minimum value to maximum value. The average deviation from the average was 5.1%. The maximum deviation from the average was 7.2%. The four highest maximum deviations from the average were 20.0, 14.8, 13.0, and 8.9%. The accuracy of this measurement is thus seen to compare favorably with the American Ceramic Society standard cross-breaking dry strength test, which specifies 10 determinations, a maximum variation from the average of 15%, and two values allowed out for exceeding this limit.

The warpage in the present test is compared with the dry cross-breaking strength because it was seen that the two varied inversely in bodies containing no feldspar.

VIII. Conclusion

Such a body trial as herein described, or some refinement of the same, offers a tool by means of which the factory laboratory can judge bodies and materials relative to those of a known body or material.

Acknowledgment Acknowledgment is made of the helpful coöperation of Ramsey Bedson in modeling the trials and making the molds.

ELJER COMPANY
FORD CITY, PA.

THE RELATION OF SODA-LIME RATIO TO THE BLENDING OF FELDSPARS[1]

By C. R. Ambrg

ABSTRACT

The possible sources of error in the blending of feldspars are discussed and the constancy of the soda-lime ratio in commercial feldspars is demonstrated. All pottery feldspars seem to contain nearly the same type of plagioclase which has a soda-lime ratio of approximately 5.25. It is recommended that this value ($Na_2O/CaO = 5.25$) be used in checking feldspar analyses for accuracy.

I. Introduction

Most of the trouble encountered in the use of feldspar has been eliminated by control of grain size and by chemical analyses. Knowing the chemical analyses of the feldspars available a constant composition for any one brand of feldspar can be maintained by blending two or more raw feldspars either from the same or different mines. There are occasional instances, however, in which blending has failed to produce a feldspar with the properties expected. The reason for these exceptions is as yet obscure.

II. Variation in Mineral Constitution

There are several possible explanations for these cases. Various feldspars have been found to contain small amounts of oxides not ordinarily sought in a chemical analysis, such as phosphates derived from apatite; boron, fluorine, and chlorine from tourmaline; beryllium from beryl; and lithium from lepidolite. These materials when present probably constitute but small fractions of the feldspar but they may have appreciable effect on the properties.

If feldspar has been weathered to any extent some of the potash, alumina, and silica may be present as sericite, a fine-grained form of white mica. This mineral is much more refractory than feldspar and its presence might decidedly alter the properties. It is a hydrated compound higher in alumina and silica than feldspar. To some extent it may be detected in an analysis by the higher alumina and the greater loss on ignition but the quantity present is almost impossible to estimate. A variation in any unknown impurity may cause a fault in the blending.

III. Variation in Type of Plagioclase

Another possible source of trouble is variation in the type of plagioclase present in the different feldspars used for blending. Any ground feldspar when viewed under the microscope will be found to consist of a mixture of microcline (potash feldspar), plagioclase (soda-lime feldspar), quartz, and

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Revised copy received September 17, 1931.

possibly a few minor impurities. The fusion temperature of the plagioclase increases rapidly with the decrease in soda and increase of lime. Since plagioclase is one of the main constituents of feldspar, a knowledge of the types and degree of variation occurring in commercial feldspars would help to understand their properties.

IV. Soda-Lime Ratio

This problem is best attacked through the soda-lime ratio or the ratio of the Na_2O in the analysis to that of the CaO. It must be kept in mind, however, that this ratio does not vary directly as the albite-anorthite composition of the plagioclase. Figure 1 shows how the soda-lime ratio, varies with the mineral composition. In the higher ratios there is little change in mineral composition with a large change in the soda-lime ratio, while the reverse is true in the lower ratios. As shown, feldspars with a soda-lime ratio above 5.25 are classed as albite, those with ratios between 5.25 and 1.35, as oligoclase, and so on.

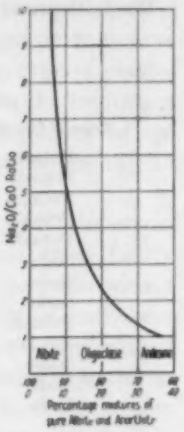

FIG. 1.—Relation of plagioclase composition to soda-lime ratio.

It is interesting to note that none of the analyses of commercial feldspars examined indicated a ratio as low as 1.35. An oligoclase of this ratio starts to melt at about the same temperature as microcline. Those with higher ratios have lower fusing temperatures. The conclusion is that the plagioclase portion of commercial feldspars should always melt before the microcline. To check this, the writer selected twenty lumps of feldspar from widely different sources and of different compositions. These were given a cone 7 treatment and then examined with the microscope. It was found that in every case the plagioclase had melted or had been converted to a glass while the microcline portions were still crystalline. The completeness of the plagioclase fusion indicated that the material must have had a considerably higher soda-lime ratio than 1.35 or in other words must have been a higher soda, lower melting composition.

V. Errors in Chemical Analysis

The big problem encountered in the use of the soda-lime ratio is the limit of accuracy in chemical analyses. Both soda and lime are small percentages in most feldspar analyses. Consequently small variations from the true analysis make a great difference in the apparent soda-lime ratio. According to Bulletin CS23–30 of the Bureau of Standards, "Commercial Standards for Feldspar," the allowable variation for soda in check analyses is 0.2% and that for lime 0.05%. This, of course, does not mean

that the analyses will necessarily check that closely with the true analysis which is unknown, for the same errors are likely to occur in both of the check analyses. If, however, it is assumed that they may have an error of $\pm 0.2\%$ from the true analysis for the soda and $\pm 0.05\%$ for the lime there is still a large possible range for the true soda-lime ratio. Table I shows the possible high, possible low, and analysis values for the soda-lime ratio of a series of feldspars from the same mine when the above postulates are accepted. If it is recognized that the check analyses may miss the true analysis by a wider margin than they do each other, the true ratio may lie outside these limits.

The feldspars of Table I were all from the same mine and analyzed by the

TABLE I

Type of feldspar	Na_2O/CaO Ratio		
	Possible high	Analysis	Possible low
Potash	18.99	13.25	9.80
Potash	9.86	7.89	6.40
Potash	8.25	6.94	5.89
Potash	7.10	5.86	4.88
Potash	6.90	5.82	4.93
Soda	4.81	4.47	4.15
Soda	4.67	4.40	3.54
Soda	4.36	4.12	3.91
Potash	4.80	4.12	3.54
Potash	4.35	3.68	3.12
Soda	3.68	3.39	3.12
Soda	3.55	3.29	3.04
Soda	3.61	3.23	2.97

same group of chemists, yet the author has found but slightly wider variation in the soda-lime ratio in analyses of feldspars from all over the country.

It is more than likely that the difference in the soda-lime ratios is not an actual difference but merely an apparent one due to the defects of chemical analysis. To study this, Fig. 2 was prepared for a statistical analysis. From a large number of analyses of potash and soda feldspars from all over the country, fifty were selected at random. The frequency with which certain ratios occurred was then plotted against the ratio. The result is the normal curve shown which has its maximum at a ratio of 4.5.* A plagioclase with this ratio may be seen from Fig. 1 to be an oligoclase very close to the albite-oligoclase

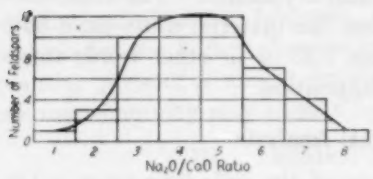

FIG. 2.—Frequency curve for fifty feldspars.

* A similar diagram constructed later from 183 analyses picked from ceramic literature gives a much sharper peak at a ratio of 5.0.

borderline. This curve indicates the probability that all commercial feldspars contain plagioclase of approximately the same composition and that apparent variations are due to defects of chemical analysis.

To verify this rather startling conclusion twenty potash and soda feldspars from different sources were examined with the microscope and the type of plagioclase present was determined as nearly as possible by measuring the indices of refraction with immersion oils. This is possible because of the fact that the indices increase in a regular manner with the increase of anorthite in a plagioclase. The study indicated remarkable uniformity in the type of plagioclase present. All the feldspars examined contained plagioclase of a composition at or near the borderline between albite and oligoclase. This would indicate that the point of maximum on the curve should be at 5.25 rather than 4.5, but the uniformity in the type of plagioclase found thoroughly bore out the conclusion reached from the frequency curve, namely, that commercial feldspars all contain plagioclase of approximately the same composition and that apparent variations are due to the inaccuracies of chemical analysis.

If this fact is accepted, it offers an explanation for some of the errors occurring in blending. One cannot secure a correct blend from faulty analyses. Any feldspar analysis which indicates a soda-lime ratio widely varying from the value 5.25 should be looked on with question and there are many such. Inaccurate analyses are a curse from which even skilled chemists are not free, as the Bureau of Standards has repeatedly found in connection with its standard samples. An examination of the recent report of the Bureau of Standards investigation of feldspars illustrates this point. Witness feldspar No. 15 of that report:[3] Analyst No. 1A secures an analysis indicating a soda-lime ratio of 4.1 which is within reasonable range from the ratio determined in this paper. But analyst No. 3 gives an analysis indicating a soda-lime ratio of 25.0, which is obviously incorrect though the analysis appears reasonable.

The remedy, of course, is a more standardized procedure in analyzing and checking by means of the soda-lime ratio which appears to be nearly a constant.

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[3] R. F. Geller and A. S. Creamer, "Investigation of Feldspar and Its Effect in Pottery Bodies," *Jour. Amer. Ceram. Soc.*, **14** [1], 38 (1931).

A PROPOSED METHOD FOR FELDSPAR FUSION TRIALS[1]

By H. B. DuBois

ABSTRACT

The purpose of the present work was to eliminate, if possible, some of the variable factors in making feldspar fusion trials and to develop some means of measuring the deformation by mechanical methods in order to keep a permanent record in definite numerical values.

I. Introduction

Up to the present time there have been no standard methods for determining the fusibility of feldspar in plant control procedure. Fusion trials have been made on tile, butter dishes, cups, and inverted insulators, but the results are indefinite since different molds are used for forming the test samples, no particular care has been exercised in the packing of the feldspar, and little attention has been paid to the heating rate.

Many of the variables of the methods generally used seriously affect the results on the fusibility obtained. The size of the test piece, the character of the structure obtained by preparing the test piece in certain types of molds, the pressure used in preparing the sample, as well as the heating rate, heating period, and method of heat application are factors which seriously affect the results.

Feldspars are said to have varying degrees of hardness and softness. In most cases no record of the degree of fusion is kept and the methods of the producer and the consumer are so varied as to cause much misunderstanding. Fusion test standards are as important as chemical or screen standards, and trials should also be made for color and specking.

II. Method Employed

A simple method has been devised which takes into consideration the several variables. Approximately two thousand trials have been made in the ten months in which this method has been in use and the results appear to be worthy of consideration.

A representative sample of the dry, ground feldspar is packed by hand in a brass mold and placed on a fired veritas disk or some similar base. The resulting test piece is in the shape of a truncated cone with a base diameter of 40 millimeters, vertical height 32 millimeters, and the diameter of the top circular area 12 millimeters. Each disk is given a number for identification and all information such as brand, car number, date of shipment, etc., is entered in a record book.

If one man attends to this work he becomes proficient in packing the feldspar in the mold. A machine may be designed to form test pieces

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio February, 1931 (White Wares Division). Received March 16, 1931.

giving even greater constancy of pressure. The volume of feldspar placed in the press should be as constant as possible and the resulting test pieces should be of the same size and each should receive the same pressure.

Trials are fired in a closed sagger in a pottery kiln. An electric furnace is used at times as a check test or to make rapid tests, but the pottery kiln fire is preferred in order to give a constant time-temperature treatment. Tests are made at a heat as nearly as possible to that used by the consumer.

A pilot material from a stored reserve whose deformation characteristics are known is made into the same shape and fired along with each sagger or series in order to check the variation in heat effect.

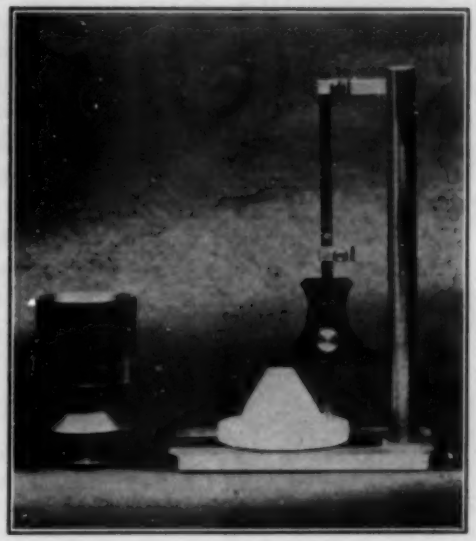

FIG. 1.

NOTE: Time-temperature variations do not seem to act on pyrometric cones and feldspar alike. Apparently the feldspar pilot is more satisfactory than the pyrometric cone due to similarity of materials and resulting viscosity; in other words, pyrometric cones are used in firing ceramic ware because they are composed of similar body ingredients and indicate time and temperature or maturity of product. Many tests seem to bear out the fact that a feldspar pilot shows the effect of time-temperature variation on the feldspar trials more accurately than do the pyrometric cones. A numerical value can also be used in recording the fusion or deformation from the original height. Tests show that pyrometric cone-sample feldspar comparisons vary considerably in the same kiln, but the pilot feldspar check-sample results in the same kiln show similar variations in time-temperature treatment.

This pilot feldspar is a standard material which is to be used to designate heat treatment. A 200-pound batch of this feldspar, carefully mixed and stored in a dry place, is a sufficient supply for a large number of tests. It has been found that the particular pilot feldspar used deforms 8 millimeters from the original height of 32 millimeters at cone 10 started. This figure is called "the accepted standard deformation" for the pilot.

NOTE: The feldspar consumer usually keeps a small amount of material from the first carload, which is his standard for checking subsequent shipments. The producer's sample from this first carload is tested in the manner described and the results are recorded as the "accepted standard" for that material. Producer and consumer will not necessarily subject the samples to the same heat treatment, but the results should be comparable if each maintains a similar testing practice.

The fired samples are measured on a device (Fig. 1) which indicates the vertical height to one-half millimeter to the base on which it has been

fired. This affords a rapid and accurate means of measurement. The difference between this reading and the original height of 32 millimeters is the deformation of the sample. The pilot for each series is measured in the same manner.

III. Results Obtained

A representative record sheet is shown in Table I. These ten tests represent carload shipments to one consumer together with the test records of these shipments.

On the first car at cone 10 started, the sample deformed 8.5 millimeters, which is its "accepted standard deformation." Pilot deformation is 8 millimeters. In the second car the pilot was the same, but the sample deformation was 10 millimeters, indicating a difference of 1.5 millimeters softer. The deformation of the first car is recorded at the top of the sheet as "accepted standard." On the sixth car the difference was two millimeters harder, but the low pilot deformation and cone deformation indicates a low fire. When a sample shows a variation of 2 or more millimeters harder or softer, it may be considered out of line, unless the pilot shows that the difference or part of the difference is due to a change in time-temperature treatment.

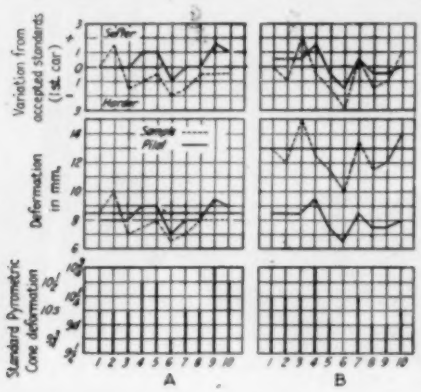

FIG. 2.

This is represented graphically in Fig. 2. In the center section, first column, the solid line indicates the deformation of the pilots and the dotted line the deformation of the samples. The center horizontal line is the accepted standard deformation of 8.5 millimeters; the parallel or danger lines show 2 millimeters harder or softer. The trials have fallen within these boundaries. Number 6 touches the lower boundary and at the same time the pilot for this trial shows less deformation representing less fusion with the heat treatment that prevailed.

The upper graphs are the same curves placed on the same horizontal axis and indicate the variation from accepted standards. If corresponding points on the two curves are widely separated, the sample feldspar is either too hard or too soft. Different companies would probably set different figures for the permissible variation.

In the second column, the curves show a softer feldspar, B. The pilot feldspar follows its standard deformation of 8 millimeters fairly closely.

Feldspar B is softer than the pilot feldspar and the curve is above. Number 6 is harder and falls below the danger line, but the pilot shows that the sample received less heat.

IV. Use of This Test by Consumer

(1) A quantity of feldspar is retained from the first car (accepted standard) as pilot material.

(2) A sample of pilot material is fired with a sample of each subsequent car.

(3) Deformation of the pilot cone is checked with test cone in millimeters.

(4) If pilot and test cone have deformed within a range which is considered safe, the tested material is regarded as satisfactory.

TABLE I

A. B. C. CHINA COMPANY

Height of unfired sample 32.0 mm.
Accepted standard for fused height 23.5
Accepted standard deformation 8.5

Test No.	Shipped	Cone	Fired height (mm.)	Sample deformation (mm.)	Pilot deformation	Variation from accepted standard	Remarks
1—1426	10–7	10 s	23.5	8.5	8.0	0.0	
2—1441	10–11	10 s	22.0	10.0	8.0	1.5 S	
3—1466	10–20	10 s	25.0	7.0	8.0	1.5 H	
4—1484	10–27	10½	24.5	7.5	9.0	1.0 H	
5—1516	11–7	10½	24.0	8.0	9.0	0.5 H	
6—1523	11–13	9¾	25.5	6.5	7.0	2.0 H	Low heat
7—1546	11–21	10 s	25.0	7.0	8.0	1.5 H	
8—1575	11–28	10 s	24.0	8.0	8.0	0.5 H	
9—1588	12–4	10¾	24.0	8.0	9.5	0.5 H	
10—1606	12–11	10½	24.0	8.0	9.0	0.5 H	

V. Use of This Test by the Producer

(1) Any feldspar is used as pilot material, providing that it is definitely predetermined that the material is uniform in fusion throughout the batch.

(2) The producer's deformation of first shipment to a customer is recorded and that deformation is regarded as the customer's accepted standard according to the producer's firing treatment.

(3) The producer checks the deformation of the pilot with the sample in the standard firing treatment. Proper deformation of the pilot indicates proper heat treatment.

(4) The deformation of the test piece with proper deformation of the pilot gives a comparison of the sample being tested with the customer's accepted standard.

VI. Conclusions

(1) The feldspar pilot cones are most accurate as indicators of feldspar fusion.

(2) The method outlined is extremely satisfactory for consumer and producer in checking uniformity of shipments because the customer can check the later shipments with the first shipment and the producer can

check the firing treatment with a pilot feldspar and also each shipment with past records.

(3) It is important to use a mold that will always give a test piece of the same size and to pack the bone-dry feldspar as uniformly as possible.

(4) The measuring device eliminates guesswork from the deformation measurement and permits both customer and producer to keep a permanent record in definite numerical values.

(5) From the consumer's standpoint, a sample variation of 2 millimeters or more from the reading of his accepted standard, when these two samples are fired together and therefore subjected to the same conditions, may be considered a variation in the fusibility of the sample feldspar. By adopting this method the consumer becomes independent of any fixed firing conditions and may make comparisons irrespective of whether or not a desirable heat treatment has prevailed.

Consolidated Feldspar Corporation
Trenton, N. J.

DESIGN AND TESTING OF A LABORATORY KILN[1]

By W. Harry Vaughan and J. P. Breen

ABSTRACT

The design of a cross-fired natural-gas laboratory kiln is described. The kiln has a ware space of 17.4 cubic feet with a range of heat treatment from cones 010 to 26 and a maximum variation within the ware space of one-half cone. The results of two economy tests are included, showing an efficiency of about 5.7%.

I. Purpose

The purpose of this test was to develop a gas-fired laboratory kiln capable of a more uniform heat distribution, greater stability, and less sensitive temperature fluctuations. It was also desired that the kiln be capable of attaining the highest temperatures practicable with natural gas and air under pressure.

II. Description of Kiln

The kiln is a rectangular cross-fired type having an area in plan of 4 feet 3 inches by 2 feet 9 inches. The net ware space was 2 feet 9 inches, 2 feet 9 inches square floor space, and 2 feet 4 inches in height. Two burners on the right side are cross-fired horizontally through 9- by 9-inch ducts underneath the floor. During the early stages of firing good control is obtained by using only the two underfloor burners.

From here the gases rise between the left wall and bag for twenty-two inches where they mingle with the gas streams of one to three burners (according to the temperature needed) of the same size set tangentially to the crown. This composite stream passes rapidly across the crown, down behind the other and shorter bag wall, mixing with the gas steams of the first two burners, and re-passing through the underfloor flues as before. In this manner the combustion gases probably pass two or three circuits of the kiln structure before they are drawn through the ware and the three slotted flue openings by the stack or draft fan.

Natural gas of approximately 1000 B.t.u. heating value at 9 inches water-gage maximum and air under 2 to 20 pounds pressure were mixed in the burners. These were home-made burners consisting of a reducing T $1^1/_2$ by 1 by $1^1/_2$ inches fitted with a tapered venturi having a base diameter of 1.54 inches, a tip diameter of 0.76 inch inside, and a length of 1.46 inches. A short length of 1-inch pipe completed the design. Gas and air lines leading to the burners were equipped with globe valves.

Undesirable limitations were made on the design. The new kiln had to be erected on the floor space of an old kiln, the old steel bracing was to be used, and the pipe connections under the floor were not to be moved.

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[1] Received July 11, 1931.

Another condition of the design was that no special shapes or expensive brick were to be used.

III. Suggested Design Changes

In view of the experience of the writers with this type of kiln, the following changes in the design are suggested:

(1) The crown should rest upon an 8-inch red brick outside wall or steel supports instead of the firebrick lining. This would facilitate refractory repair, make possible a $4^1/_2$-inch refractory lining, and allow the insulation to be placed close enough to be of value at temperatures of about 2200°F.

(2) Channels or I-beams should be tied in with rods below the main flue as well as above the crown.

(3) The insulation should be $4^1/_2$ inches of C_{22} brick and 2 inches of

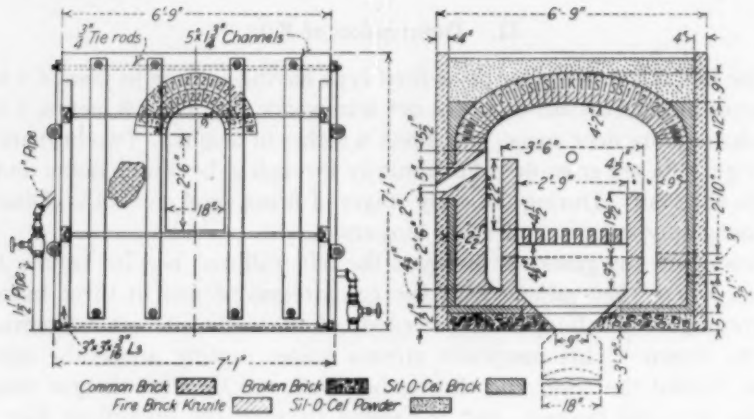

FIG. 1.

Sil-O-Cel powder tamped between the fire brick and the red brick or metal walls.

(4) The finest, but probably the most expensive, method of outside wall construction would consist of an $^1/_8$-inch steel shell backed by off-set I-beams with the crown brick starting in channels bolted to these beams.

(5) Super-refractory brick should be used to construct at least the tops of the underfloor flues.

(6) An increase in the thickness of the walls of the underfloor flues with an attending increase in the depth of the kiln ware space is recommended.

(7) It is probable that the use of special book tile for the construction of these underfloor flues and the possibility of using three burners under the floor instead of two would improve the performance of the kiln.

(8) Firing cocks instead of the globe valves for regulating the gas and air would be advisable.

Although these changes would be desirable, the present kiln is in good condition after several firings ranging from cones 18 to 30.

Bill of Materials

Fire brick

77 straights ($13^1/_2$ in.)	1283 straights (9 in.)
130 No. 1 wedge	28 No. 2 wedge
56 No. 3 wedge (necks)	20 No. 1 arch
46 No. 2 arch	3 soaps

Sil-O-Cel

625 straights (9 in.)	200 lb. powder

Common brick

1000 ($2^1/_4$ x $3^3/_4$ x 8 in.)

Miscellaneous

4 sacks refractory cement	2 sacks lime
4 sacks Portland cement	8 sacks sand

IV. Economy Tests

For testing, the kiln was loaded with 1009 pounds of Kruzite fire brick which were calculated to have a specific heat of 0.27 B.t.u. per pound per degree Fahrenheit over the temperature range used. This type of loading was selected to make the calculation of the heat absorbed by the ware accurate.

V. Apparatus

The apparatus used for measuring the firing conditions consisted of a gas meter, pyrometer of the galvanometer type, nine chromel-alumel thermoelements connected to a common cold junction compensator by means of compensating lead wires, a potentiometer, two flue-gas samplers (one located at the outlet from the kiln to the main flue and the other about nine feet up the main flue from the kiln damper), an aspirator pump for keeping a continuous sample of flue gas flowing so that any analysis represented about ten minutes in the flue atmosphere, an Orsat analysis apparatus, cones, differential and static pressure draft gages of the inclined type connected to pitot and static pressure tubes in the main flue, four thermometers for wall and room temperatures, chemicals for the Orsat, log sheets, and temperature graphs for the firing schedules.

VI. Procedure

Temperature readings were taken every 20 minutes of the control pyrometer, crown, top of ware, bottom of ware, inner face of firebrick lining, junction of firebrick and Sil-O-Cel linings, junction of the Sil-O-Cel and red brick wall, combustion gases at kiln bottom, main flue entry and gas sampler, outside of the common brick wall, outside of the wicket, over the crown, and of the room.

Static pressure readings at the bottom of the kiln leading into the main flue and at the gas sampler, and differential pressure readings at the gas sampler were taken every 40 minutes. These readings were too low in most cases to be of any significance since the main flue was much larger than necessary to take care of the capacity of the kiln.

The analysis of flue gas was made every 40 minutes by means of an Orsat working intermittently from a reservoir. While the composition of the natural gas was not determined, the composition runs fairly uniform so that fluctuations normally encountered would not affect the flue-gas analysis appreciably nor the heating value more than about 10 B.t.u. per cubic foot. This gas is pumped from the Monroe, Louisiana, fields by the Southern Natural Gas Corporation. While samples of the flue gas were normally taken from the main flue, every three hours a sample was taken from the main entry as a check to determine the leakage into the main flue.

The gas meter was read every 20 minutes. Ice was renewed in the cold junction bottle when necessary. The firing period was eighteen hours in each case, the fixed galvanometer pyrometer installation being used as a criterion. Induced draft was used during the latter half of the firing.

VII. Data

The variation in heat distribution during the first firing was two cones. In the second firing, the variation was about $^1/_4$ cone at cone 12. The difference in results was due to greater experience with the cross-firing principle of operation. Since the second firing, the same heat distribution results have been duplicated several times.

HEAT ACCOUNTS

		1st firing		2nd firing		
	Sp. Ht.	M B.t.u.	(%)	M B.t.u.	(%)	Average (%)
(1) Absorbed by kiln structure						
Material						
Fire brick (10,850 lb.)	0.27	3950	39.72	4340	40.00	39.81
Sil-O-Cel C_{22} (1563 lb.)	0.28	154.5	1.55	191.0	1.76	1.66
Red brick (5500 lb.)	0.23	126.5	1.27	200.0	1.84	1.55
Refractory cement (280 lb.)	0.29	109.4	1.10	120.0	1.10	1.10
Sil-O-Cel powder (200 lb.)	0.28	2.8	0.02	7.5	0.07	0.05
Cement mortar (1200 lb.)	0.25	27.3	0.30	47.5	0.44	0.37
Wicket (F. B. and C_{22})		153.1	1.54	168.6	1.55	1.54
Total		4523.6	45.50	5074.6	46.76	46.13
(2) Loss through kiln walls		84.4	0.85	125.0	1.15	1.00
(3) Stack loss 2nd sampler		1585.5	15.98	593.9	5.47	10.72
(4) Loss kiln bottom and flues		2527.6	25.42	3798.6	34.95	30.18
(5) Loss unaccounted for		617.8	6.20	660.3	6.10	6.15
(6) Absorbed by ware		587.0	5.93	607.5	5.60	5.77
Total input		9926.0	99.88	10860.0	100.03	99.95

VIII. Summary

A laboratory kiln was produced incorporating a semi-muffle effect in the floor which showed good heat distribution and good control during all stages of firing. The efficiency is about 5.7%. Firing to cone 26 may be accomplished with natural gas. Certain changes in design are recommended. Temperature rises of 20 degrees per hour can be maintained during the early stages of firing. A higher temperature can be maintained in the top than in the bottom if desired.

By loading the kiln with a known weight of previously fired brick of known specific heat, the heat absorbed by the loading could be accurately figured. It will be noted that the unaccounted for heat loss was as great as the input to the kiln loading.

The heat absorbed by the kiln structure averaged more than 46% of the total input. Almost 40% of the heat input was absorbed by the firebrick lining. The kiln bottom and stack loss amounted to about 41%.

IX. Conclusions

A similar type of kiln incorporating the changes recommended is a satisfactory type of laboratory kiln for a large range of heat treatments with good heat distribution and control. The same type of kiln has been satisfactorily adapted to gravity oil and low pressure air firing in another laboratory. Excellent flashing of shale products has been accomplished in the latter kiln.

The design feature recommended concerning the thickness of the firebrick lining (reduction from 9 inches to $4^1/_2$ inches) is indicated by the economy test data. If one-third of the heat absorbed by the lining could be saved, the efficiency of the kiln would be increased to 6.6% and the heat distribution would be improved. There is also the possibility of saving considerable heat by installing a system of cast-iron pipes for preheating the air before it is admitted to the burner. This preheating is practical to about 800°F in the case of air and natural gas provided the gas consists principally of methane. The efficiency of such a kiln might easily be doubled (11.4%) by means of the two changes indicated.

The value of insulation in a small laboratory kiln having a 9-inch firebrick lining is doubtful for heat treatments below cone 12. At the higher heat treatments, however, the insulation is of considerable value both in preventing heat transfer and in producing a uniform heat distribution in the kiln lining.

Acknowledgment The kiln was designed by the senior writer and built by L. A. Teeder. The economy tests were conducted by the 1931 Ceramic Engineering class. The drawings and calculations are by the junior writer.

GEORGIA SCHOOL OF TECHNOLOGY
DEPARTMENT OF CERAMIC ENGINEERING
ATLANTA, GEORGIA

LABORATORY TEST KILNS[1]

By A. S. Watts and J. L. Carruthers

ABSTRACT

Three gas-fired downdraft test kilns built by the Ceramic Engineering Department of the Ohio State University are described and detailed drawings and bills of material are given. Results obtained with each kiln are discussed briefly.

I. Introduction

The three laboratory kilns herein described were built during 1928 by the Department of Ceramic Engineering of the Ohio State University. The kilns have been uniformly successful in firing all kinds of ware and trial test pieces at various temperatures. The kilns are flexible in operation. It is possible to maintain practically any desired rate of heating or cooling, and to produce either an oxidizing, neutral, or reducing atmosphere in the kilns.

II. General Remarks

The three kilns are fundamentally alike in general design, varying only in size, burner arrangement, and construction of the bottom flue system. The results obtained with each kiln have not indicated that any particular kiln bottom or burner arrangement is to be preferred.

The kilns are of the direct fire, downdraft type and are so designed that they may be attached either to an underground flue or directly to an adjacent stack by a flue above grade. In the installation described, the three kilns are attached to a stack thirty-five feet high by a horizontal flue built on the floor of the kiln room. Dampers made of heavy transite board are used to regulate the draft for each kiln.

III. Fuel and Burners

Natural gas with a heating value of approximately 1000 B.t.u. is delivered to the burners at a pressure of four ounces.

Four burners are provided on each kiln for normal firing requirements which ordinarily do not exceed cone 16. These burners consist of a 1-by 2-inch air-gas mixer with a piece of 2-inch pipe 18 inches long for a nozzle. The nozzles must be replaced at intervals since the ends burn off. The gas flow to each burner is regulated with a 1-inch globe valve. The air for combustion is controlled by means of the shutter in the mixer, the amount of free space around the burner nozzles, and also to some extent by the intensity of draft.

The burners are simple and inexpensive and perhaps are not as efficient

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[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Structural Clay Products Division). Received August 15, 1931.

as some other types. Such items, however, as cost, student firemen, and the results obtained, justify their use.

On the small kiln (No. 2), two additional burners are provided to obtain

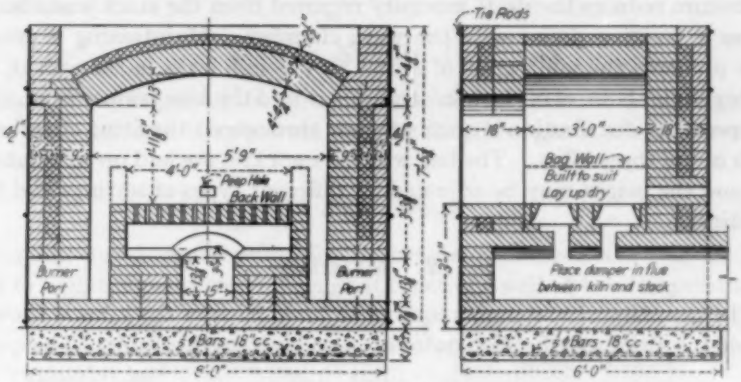

FIG. 1.—Kiln No. 1.

temperatures above cone 16. On one occasion this kiln was fired to cone 30 by using all six burners. Also on another occasion, kiln No. 2 was fired to cone 26 without using the two high-temperature burners, but this was

TABLE I

Item	Quantities Kiln 1	Kiln 2	Kiln 3
Common brick	1900	1200	2000
Insulating brick	1200	700	700
Fire brick (9 in.)*	2500	600	2100
End skew brick	90	75	70
No. 1 arch brick	55		30
No. 2 " "	100	100	25
No. 1 wedge "	135	75	115
Slab ($13^1/_2$ x 9 x $2^1/_2$ in.)	9		9
Floor block (See Fig. 1)	28		16
Portland cement (sacks)	9	6	9
Sand (lb.)	3300	2000	3000
Lime (50-lb. sacks)	2	1	2
Ground fire clay (lb.)	1200	400	1000
Rod A	8	6	8
Rod B	8	6	8
Steel angles	6	8	8
Air-gas mixer	4	4	4
Burner nozzles	4	4	4
$^3/_8$-in. steel washers	130	100	130
$^3/_8$-in. lock washers	120	96	120
1-in. globe valves	4	4	4
Blast gates		2	
1-in. gas regulating cock		1	
Gas burner		2	
Premix blower		1	

* About 5% of the 9-in. brick should be replaced by the equivalent in soap brick or large 9-in. straights in order to reduce the costs of masonry labor.

NOTE: Foundation materials are not included in the above bills of material.

due to several unusual conditions. The additional burners are the "stick-tite" type and are connected to a Maxon Premix blower.

The gas burners are placed well below the level of the kiln floor. This procedure reduces the draft intensity required from the stack and also produces a positive pressure in the ware chamber. Maintaining a pressure here prevents the infiltration of excess air through leaks in the wicket, thus giving better control of the kiln atmosphere and the kiln temperature. The temperature distribution is quite uniform throughout the firing chambers of each of the three kilns. The bag walls in each kiln are laid up without mortar and the height may be adjusted for different types of settings and firing conditions.

IV. Materials

The quantity of materials required to build each of the kilns is shown in Table I. Brief specification notes are also given in this table. The quality of refractory used in test kilns should be of the best grade obtainable consistent with the firing conditions to be used, since repairs are always somewhat difficult and relatively expensive on small kilns.

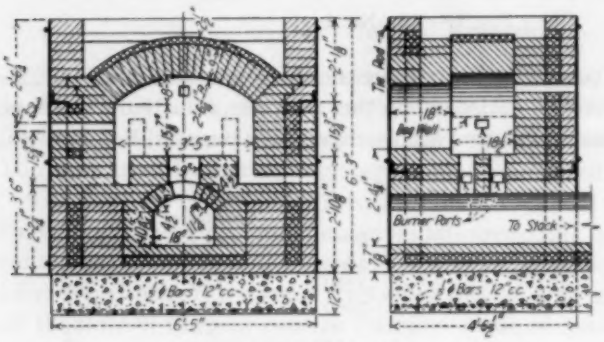

FIG. 2.—Kiln No. 2.

The cost of building each of the three kilns was not determined, since materials and labor for all three were furnished under one contract price. The No. 1 kiln, however, was duplicated by the Ceramic Art Department of the Ohio State University in 1929 for six hundred and fifty dollars. This price included foundation, kiln, burners, and a six-foot flue connection to an existing stack.

V. Kiln Controls

All controls on the kilns, including temperature, atmospheric, and draft, are manually operated. On one occasion, for demonstration, the largest kiln was fitted with a time-temperature control device to regulate the kiln temperature curve. Excellent results were obtained, and such devices are recommended where the kilns are used for control work.

The thermocouples are inserted through holes left in the kiln wickets and project about six inches into the kiln chamber. A hole may be provided

either in the crown or the back wall of the kiln for a permanent thermocouple installation. Peepholes for sighting pyrometric cones, pulling draw trials, or for using an optical pyrometer are provided in building the kiln wicket.

VI. Kiln No. 1

This kiln, the largest of the three, has been fired to cone 16 down in thirty hours, with uniform temperature distribution throughout the whole ware chamber.

VII. Kiln No. 2

This kiln was designed primarily for firing small amounts of ware or test trials to high temperatures, although it functions well at low temperatures.

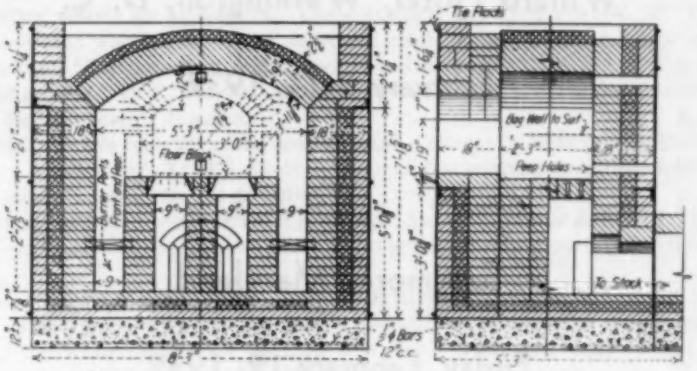

FIG. 3.—Kiln No. 3.

On one occasion it was fired to cone 30. The setting space is about four and one-half cubic feet.

VIII. Kiln No. 3

The available setting space in this kiln is approximately thirteen and one-half cubic feet. The kiln has been fired to cone 18 with the burner equipment described and could perhaps be fired to a higher temperature if sufficient time were taken. The flue system and burner arrangement are quite different from those of the other two kilns, yet no perceptible difference in results has been noted.

THE OHIO STATE UNIVERSITY
DEPARTMENT OF CERAMIC ENGINEERING
COLUMBUS, OHIO

Thirty-Fourth Annual Meeting
The American Ceramic Society

◆ ◆ ◆ ◆

Willard Hotel, Washington, D. C.

February 8-11, 1932

and

Baltimore, Maryland

Friday, February 12, 1932

◆ ◆ ◆ ◆

National Brick Manufacturers Research Foundation
Symposium on Reinforced Brick Masonry

Thursday, February 11

Willard Hotel

CERAMIC ABSTRACTS[1]

Compiled by the

AMERICAN CERAMIC SOCIETY

Ross C. Purdy, Editor

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Vol. 11 **February, 1932** **No. 2**

Abrasives

Grinding wheels for high finish. Carborundum Co. *Brass World*, **27** [11], 236 (1931).—A solid wheel made of the finest and most uniform grains and grits in both "Aloxite" and "Carborundum" and a special bond is described. E.P.R.

Small grinder. P. W. Druitt. *Mech. World*, **90** [2342], 497 (1931).—A small wheel grinder for light tools is described. E.P.R.

Special abrasive tools for motor manufacture. Reliance Electric & Engineering Co. *Abrasive Ind.*, **12** [12], 13–15 (1931).—A few grinding operations followed in electric motor manufacture are described. E.P.R.

Precision and economy in internal grinding. Anon. *Abrasive Ind.*, **12** [12], 22–23 (1931).—Internal finishing of holes and bores in various machine parts is described. E.P.R.

Hand polishing machine parts. Edward S. Heck. *Abrasive Ind.*, **12** [12], 34–38 (1931).—Parts polished and buffed in the manufacture of domestic sewing machines made by the White Co. are, for the most part, small in size and require a high finish. The apparatus and methods employed by this company are described. E.P.R.

Grinding drill shanks. Anon. *Eng. Mining World; Queensland Mining Jour.*, **32** [10], 413 (1931).—To prolong the life of drill pistons and chucks and insure smooth drilling, truly squared-off shank ends are essential. This is accomplished by grinding the ends manually in a stationary emery grinder. A jig with which the shank ends can be trued mechanically was developed. E.P.R.

Grinding and heat treatment as a cause of cracks in hardened steels. C. E. Sweetser. *Heat Treating & Forging*, **17**, 776–80 (1931); for abstract see *Ceram. Abs.*, **10** [11], 743 (1931). (*C.A.*)

BULLETINS

Roll-grinding data. Anon. *Abrasive Ind.*, **12** [12], 28 (1931).—A new 20-page catalogue containing illustrations, descriptions, and specifications of the new Cincinnati 20-, 24-, 28-, 32-, and 36-inch roll-grinding machines has been issued by the Cincinnati Grinders, Inc. Specifications are listed for 49 sizes of machines. E.P.R.

Preparation of graded abrasives for metallographic polishing. J. L. Rodda. *Amer. Inst. Mining Met. Eng., Inst. Metals Div., Tech. Pub.*, No. 438, 9 pp. (1931); for abstract see *Ceram. Abs.*, **10** [11], 743 (1931). (*C.A.*)

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.
The bold-face number following the journal name is the volume, the issue number is in brackets followed by the page numbers, then the year in parentheses.

PATENTS

Saw gummer. JAY E. PORTER. U. S. 1,832,878, Nov. 24, 1931. A horizontal shaft, a supporting member in which the shaft is mounted including a bearing housing at one end of the shaft through which the shaft passes, the shaft having a tapered enlargement located in the housing, an interiorly tapered bearing sleeve around the enlargement, the sleeve being located in the housing and pressing at one end thereagainst, spring means mounted on the shaft and engaging against the bearing housing for drawing the tapered enlargement into snug engagement with the sleeve, a second bearing sleeve located around the shaft in front of the enlargement thereof extending into the bearing housing and partly over the front end of the first bearing sleeve, means for detachably securing a circular saw to the front end of the shaft, a bearing for the rear end portion of the shaft, and means for periodically turning the shaft with a step-by-step movement.

Grinding attachment for milling machines. GEORGE C. REID. U. S. 1,832,997, Nov. 24, 1931. A grinding attachment for milling machines comprising a post, a clamp at the upper end of the post for mounting it on the overarm of a milling machine, a base fixed to the lower end of the post and having an annular groove in its lower face contracted at its open side and enlarged at a point for the ingress and egress of bolt heads, an electric motor, a base carrying the motor and fitting against the grooved face of the post base and having spaced notches in its periphery, a centering pin between the two bases having its opposite ends seated in sockets in the opposed surfaces of the bases and entirely housed thereby, the groove in the base of the post being concentric with the pin, bolts engaging the peripheral notches in the base of the motor and having their heads held in the contracted annular groove of the base of the post, and a grinding element fixed on an end of the shaft of the motor.

Trimming abrasive wheels. HERMON G. WEINLAND AND GEORGE E. VANCE. U. S. 1,833,667, Nov. 24, 1931. A rotatable spindle to support and rotate an abrasive wheel, a movable supporting member, a tool and its holder mounted on the supporting member, means for moving the member toward the wheel to adjust the tool with relation to the wheel, a controlling rheostat, a connection between the rheostat and the movable supporting member, the connection consisting of a sprocket on the shaft of the rheostat, a second sprocket on the frame of the machine, a chain passing over the sprocket, and a connection between the chain and the movable supporting member.

Water-proof polishing paper. CARL KINGSPOR. U. S. 1,833,715, Nov. 24, 1931. The method which comprises applying a mixture of glue, unsolidified phenolaldehyde mixture, and an alcoholic diluent to a carrier base at a moderately high temperature of about 75 °C, applying an abrasive to the layer obtained on the carrier base, covering the resulting layer with liquid organic sizing material, and then gradually raising the temperature of the coated carrier base to a solidifying temperature of about 150 °C during a period of from about 10 to 36 hours.

Wheel dresser. SYDNEY MARQUIS. U. S. 1,833,845, Nov. 24, 1931. A wheel dresser comprising an assembly of two series of toothed disks, each series consisting of a plurality of dressing disks of the same diameter, the series being distinguished one from the other in consisting of disks of different diameters, and the disks of different diameters being arranged in alternate relation so as to furnish a continuous effective picking action until the teeth of the smaller disks have been worn down.

Grinding machine. GEORGE V. JOHNSTON. U. S. 1,834,158, Dec. 1, 1931. A centerless grinder including a bed or support, a high-speed grinding wheel carried thereby for removal of stock from a work piece, a regulating wheel disposed in opposition to the grinding wheel and providing in conjunction therewith a work-receiving throat,

means for imparting relative movement to the parts to vary the width of the grinding throat, a work-supporting member projecting in the throat between the wheels, an oscillatable means for supplying work pieces to the throat and subsequently removing them therefrom, operable in time sequence with the movement of the parts forming the grinding throat.

Truing and dressing grinding wheels. ROLAND P. PLACE. U. S. 1,834,179, Dec. 1, 1931. The combination with a tail center, of an abrading wheel revolubly and concentrically mounted thereon, and means for reciprocating the grinding wheel to bring it into engagement with and rotate the abrading wheel.

Measuring device for precision grinders. FRED H. WHITMAN. U. S. 1,834,231, Dec. 1, 1931. A device comprising a gaging element, means for periodically causing the gaging element to contact with the piece being worked, measuring mechanism functioning in conjunction with the gaging element for indicating the gage of the work piece, and additional means functioning in conjunction with the gaging element and adapted to cause the termination of the working operation when the piece being worked has attained a predetermined degree of precision.

Mounting for tooth rest of cutter grinders. WILLIAM E. WINANS. U. S. 1,834,815, Dec. 1, 1931. A mounting comprising a base having an arcuate end, calibrations of degrees of angularity inscribed on the arcuate end, a tooth-rest arm supporting member pivotally related to the base, the member having an arcuate end coinciding with the arcuate end of the base for calibration registration therewith, the supporting arm being adjustable transversely of the platen, and a tooth-rest finger carried by the end of the arm.

Grinding tools. FERDINAND SATTERSTROM. U. S. 1,834,972, Dec. 8, 1931. In an apparatus for grinding cutter heads, each having a plurality of cutter blades and a longitudinally extending guide tongue or rib adjacent to each blade, the combination of a support for the cutter head, a grinding wheel, a cutter guide member adapted to engage a wall of one of the guide tongues, and a yieldable element supported on the guide member and adapted to engage the opposite wall of the guide tongue and hold the guide member in contact with the tongue to prevent back lash, whereby each cutter blade may be accurately ground.

Grinding machine. JOHN H. HELMS. U. S. 1,835,045, Dec. 8, 1931. In a cylinder grinding machine, a bed, a tool shank rotatably and slidably mounted above the bed, a holding plate, means for adjusting the plate on the bed, centering pins carried by the holding plate for receiving a cylinder, a sleeve slidable on the shank, a centering head slidable on the sleeve having a pin for engaging the cylinder to be ground, and a grinding tool carried by the lower end of the shank.

Grinding machine. VICTOR E. FLODIN. U. S. 1,835,291, Dec. 8, 1931. In a grinding machine, the combination of a surface-finishing tool adapted to operate over a plurality of points in one plane, with means for supporting an article having opposite surfaces to be finished in predetermined relation to one another in operative relation to the tool, comprising means for holding and positioning the article with one of the surfaces in predetermined relation to the tool and means for moving and positioning the holding means to position the opposite surface of the article in predetermined relation to the tool and the first finished surface.

Grinding fixture for valve body seat rings. VICTOR E. FLODIN. U. S. 1,835,292, Dec. 8, 1931. In combination, a grinding machine having a grinding tool presenting a grinding face and means for securing an article with its opposite sides in predetermined relation to the grinding face comprising a base member, an article support having an article positioning surface secured to the base member, a split collet about the support above the surface, and means for contacting the collet against the periphery of an article

resting against the surface, the positioning surface being arranged in predetermined relation with respect to the contacting surface of the collet.

Grinding fixture. JOSEPH C. DRADER. U. S. 1,835,476, Dec. 8, 1931. Means for grinding a helically shaped cutter tooth comprising, in combination, a grinding wheel and a cutter-supporting fixture adapted for movement relative to each other, the fixture comprising a shaft extending through spaced bearings and having a relative axial movement with respect to the wheel, means including a sleeve extending through one of the bearings and also a projecting cam rail secured on the sleeve and providing parallel cam surfaces for the wheel for imparting a rotary movement to the shaft upon the relative axial movement between the shaft and the wheel, and correspondingly spaced cam guide means coöperating with the respective cam surfaces of the rail.

Grinding machine. WILLETTS PEASLEE. U. S. 1,835,668, Dec. 8, 1931. In a centerless grinder, the combination of a bed, a pair of opposed grinding and regulating wheels carried thereby and forming a grinding throat therebetween, a work rest subtending the grinding throat and forming a work-supporting trough with the face of the regulating wheel, means on opposite sides of the throat forming a guiding trough for introducing work pieces to the grinding throat and receiving the work after it passes from the throat, and means for supporting the work above the receiving trough for return to the opposite side of the throat.

Backing-off mechanism for grinding machines. HARVEY M. ALLISON. U. S. 1,835,687, Dec. 8, 1931. In a grinding machine, a grinding wheel, a wheel head, a wheel slide, a wheel-slide support, a rock shaft mounted in bearings at the rear of the support and directly connected to the rear of the wheel slide, an arm on the rock shaft, an eccentric member mounted on the support and rotatable in timed relation to the rotation of the work, and a link extending forward from the arm and above the wheel-slide support and having a bearing portion fitting the eccentric member.

Measuring machine. JOHN W. PARKER. U. S. 1,835,807, Dec. 8, 1931. An electrical measuring device for trimming machines including movable work-engaging means, means whereby the work-engaging means is kept in constant positive pressure against the work as trimming progresses, two capacitor circuits each having a fixed plate and having one movable plate in common, the movable plate being carried by the work-engaging means so as to move therewith, a multirange galvanometer having ranges whose ratio is that of the capacitance of the two circuits, and means whereby the galvanometer may be selectively inserted into the capacitor circuits to obtain readings on the respective scales of the galvanometer.

Knife-holding attachment for grinders. WARREN R. SMOUT. U. S. 1,836,292, Dec. 15, 1931.

Heat treatment of garnet abrasive. EDWIN W. COLT. U. S. 1,836,448, Dec. 15, 1931. As an abrasive, crushed garnet heated at a sufficiently high temperature over a sufficiently extended period of time to convert a portion of the iron in ferrous form into the ferric form, to change the color to a deeper red and to increase the hardness.

Grinding machine. ARTHUR H. LYON AND HANS T. R. HANITZ. U. S. 1,836,482, Dec. 15, 1931. In a grinding machine, a work holder, a swinging support, and a grinding member mounted for reciprocal movement on the support.

Grinder. PATRICK T. LENNON. U. S. 1,836,807, Dec. 15, 1931. In combination with a grinder, a pivoted headstock and a pivoted footstock for supporting a multi-bladed cutter adjacent to the grinding wheel, feed mechanism for rocking the stocks toward the grinding wheel, a strut engageable successively with the teeth of the cutter and transmitting motion received therefrom to the feed mechanism, means for rotating the cutter, and means for relatively moving the cutter and grinding wheel longitudinally.

Grinding ball races. LANDIS TOOL CO. Brit. 359,978, Nov. 11, 1931.

Manufacture of abrasive articles. CARBORUNDUM CO., LTD. Brit. 360,482, Nov. 18, 1931.

Grinding or abrading machines. W. W. TRIGGS. Brit. 360,557, Nov. 18, 1931.

Centerless grinding machines. CHURCHILL MACHINE TOOL CO., LTD., AND H. H. ASBRIDGE. Brit. 360,964, Nov. 25, 1931.

Lapping or polishing machines. NORTON CO. Brit. 361,488, Dec. 2, 1931.

Art and Archaeology

Gold preparation for the ceramic industry. P. P. BUDNIKOFF. *Ber. deut. Keram. Ges.*, **12** [6], 279 (1931); *Chem. Zentr.*, **102** [6], 891 (1931).—The problem of preparing gold for the ceramic industry has been solved. The different methods more or less apply the same principle, but in no way is the problem of the chemical reactions solved. B. proved in a previous paper that the sulphur reacts with the turpentine (pinene) and $C_{10}H_{16}S$ reacts with the salts of the heavy metals in complex combinations. The metal is supposed to be in direct combination with S, though B. does not deny the possibility of colloidal S being present also. Further experiments reported were done with a mixture of 200 g. pinene from French turpentine (boiling point 155 to 156°C) by adding S and boiling for 6 hr. The "sulphur balsam" developed was distilled. The results (treating with CH_3OH the different fractions, etc.) prove that S and terpene form terpene-sulphide. Polymerization is possible at higher temperatures. An addition of S_2Cl_2 favors the precipitation of terpenous sulphide. B. explains the methods of gold preparations of Schenck and Chemnitius (see *Ceram. Abs.*, **7** [6], 344; [12], 808 (1928)), the chemical reactions, and the advantages and disadvantages of the different products concerning their workability, firing resistance, etc. See also abstract by Tishchenko and Smirnov, *Ceram. Abs.*, **10** [10], 676 (1931). I.R.

Decorating pottery. G. HUMBERSTONE. *Brit. Ind. Finishing*, **1** [12], 277–78 (1931); *Sprechsaal*, **64** [31], 578 (1931).—Photographic decalcomania is discussed. Borders of one color can be made by applying linseed oil on an engraved copper plate, wiping off the surplus, and pressing the design on a special glue or wax strap dusted with finely ground color. This is fired. Borders can be made by pressing cylinders or panes containing the relief design on a pad provided with a thin color film and then transferring the design on the object. Designs are made also by hand and blending or shading is done with a small air pen. Cellulose enamels used are not of the same composition and quality as those which are used in other industries. There are different methods of applying them, *i.e.*, several colors are squirted on the object while it is wet and a coat of mist is afterward obtained by a special lac. The colors run down and produce waves and veins. A "Lymnato-pistol-spray" used in France is described. M.V.K.

New decorating process. ANON. *Sprechsaal*, **64** [41], 756–57(1931).—Some drops of a copper sulphate solution are placed on filter paper. After drying, a drop of potassium ferrocyanide solution is placed on the same paper. A spot of copper ferrocyanide forms which shows sharp contours in the filter paper. A ceramic body may be decorated in the same manner. A solution of ammonium oxalate, ammonium phosphate, or potassium ferrocyanide is first put on the surface of the body. Then solutions of copper sulphate, iron sulphate, etc., which originate in colored salts to be used for decorating purposes, are poured on the body. Glazing and firing are done as usual. It is possible in this way to make beautiful and changing designs. W.M.C.

Red of selenium as red pigment for ceramics. ANON. *Ind. chim.*, December, 1929; **17** [197], 409 (1930).—By mixing selenium oxide with cadmium sulphide in different proportions and by calcining it in a muffle kiln, a red coloring matter is obtained. The best results are obtained with a mixture containing 20% selenium oxide and 80%

cadmium sulphide. While hot, this mixture has a brown and black color which changes into red on cooling. By replacing cadmium sulphide by zinc sulphide, the color becomes weaker. The mass has a fusion point of about 700° and can be used in ceramic kilns. Borax develops the red color in an extraordinary way. Other substances may be added, *e.g.*, borate of lime or zinc oxide. Small quantities of litharge promote fusibility. See also *Ceram. Abs.*, **10** [1], 9 (1931). M.V.K.

Paintings for decorating glass. ANON. *Moniteur Peinture*, February, 1930; *Chim. ind.*, **17** [197], 409 (1930).—Water-color painting can be done on glass or under glass by mixing the pigments with gummy liquids (gum of Senegal or gum tragacanth). Oil paint is made more durable by a small addition of colophan (1 to 2%) added in solution to the turpentine. Paints with egg yolk consist of a mixture of pulverized colors with water egg yolk. Celluloid paint is extensively used also. Generally, all pigments used in painting can be used for painting glass. The best pigments to be used for glass and the way in which they should be mixed are described. M.V.K.

Defects in faience-glazed ware caused by quartz sand in the mass. P. P. BUDNIKOFF AND M. I. SOLOMONOV. *Ceramics & Glass*, **7** [7–8], 41–43 (1931).—The reasons for swellings and punctures on the bodies of faience-glazed ware are discussed. These defects appeared when the flint in the body was replaced by quartz sand. The formation of these defects is due to the fact that quartz grains expand with the modification change of the silica. The most dangerous volume increase of the quartz grains and their conversion takes place between 500° and 585°. During the second firing of the glazed ware this transformation and the increase in the size of grains continues and produces bursting in the glaze layer. With repeated firing in a kiln, the defects disappear when the glaze is melted. Quartz sand should be fired before using or the ware should be fired to 1280° to avoid these defects. M.V.K.

Fastness to light of mineral pigments. M. C. LAMB AND R. DANYER. *Leather Trades Rev.*, **64**, 657 (1931).—This is a report to the Federation of Curriers on the permanence of naturally occurring pigments like china clay, talc, ochre, and of prepared inorganic compounds of Ti, Pb, Zn, Al, etc. H.H.S.

Modern electroplating works at Slough. FRED GROVE-PALMER. *Metal Ind.* [London], **38** [5], 147–48 (1931).—G. describes the electroplating of porcelain, glass, wood, plaster, etc. Gold and silver are deposited upon fine porcelain or glassware and give excellent adhesion. Not plated china, but china-lined silver or gold vessels are produced. Cheap earthenware jugs, basins, dishes, etc., are plated with copper and nickel making them practically unbreakable. Cocktail glasses adorned with the crest of the owner in silver and boudoir glassware with gold rims and flowers are attractive. M.V.K.

Design as a merchandising factor. I. RICHARD F. BACH. *Merchandise Manager*, pp. 17–18 (July, 1931).—B. traces the history of design to 1900 at which time there was much organization but no interorganization, great quantity but no design quality, fine material, and consummate workmanship concerned with weight, dimension, and utility but not with design. **II.** *Ibid.*, pp. 29–30 (Aug., 1931).—After the war the retailer realized that design sells goods and better design sells more goods. This idea was overworked through the use of modernistic design. This was followed by a saner period which was hurt through the depression. The price war is on, but why play down to price when playing up to design would carry so much better? There is thrift in good design. (*D.I.*)

New ceramic handwork. W. RIEZLER. *Form*, pp. 285–92 (Aug., 1931).—The idea that form is everlasting, timeless, and universal is applied to ceramics. Form is natural in contrast to ornament which is artificial. The artists adapt glaze to form to make a harmonious whole without extraneous ornament. Illustrated. (*D.I.*)

Art departments for industry. W. D. H. McCULLOUGH. *Commercial Art*, pp. 49–56 (Aug., 1931).—A symposium of manufacturers gives its opinions as to the need of linking up art with industry more closely and the possibility of having art consultants and advisors to collect ideas, test markets, and train designers and craftsman. (*D.I.*)

Octagonal china. HEINRICH & WINTERLING, INC. *Crockery Glass Jour.*, **109** [11], 49 (1931).—The "Bella," an octagonal shape, is featured. E.P.R.

New glassware. ANON. *Crockery Glass Jour.*, **109** [11], 28 (1931).—New designs offered by the Cambridge Glass Co. and Paul A. Straub, Inc., are described. E.P.R.

Vogue in glassware. MABEL J. STEGNER. *Better Homes & Gardens; Nat. Glass Budget*, **47** [30], 19 (1931).—The waning of popularity of high color in table appointments is followed by the trend in glassware from bright colors to soft tints. E.P.R.

Color on the dining room table. WILLIAM J. MISKELLA. *Ceram. Ind.*, **17** [6], 444–47 (1931).—M. discusses color preferences. W.W.M.

Glass of today. ARNOLD FLEMMING. *Atelier*, pp. 73–93 (Aug., 1931).—The article is especially interesting because of its illustrations giving examples of many of the distinguished contemporary Continental glassmakers, *e.g.*, René Lalique, Marianne Rath, and Orrefors glass. Its purpose is to stimulate an inventive spirit among the technically expert craftsmen and glassworks in Great Britain. (*D.I.*)

Sculpture in glass. ANON. *Pottery Gaz.*, **56** [654], 1637 (1931).—A head carved from a solid block of crystal by Aristide Colotte of Nancy, and a series of pieces including one formed from a block of glass weighing 500 lb. are illustrated. E.J.V.

Domestic art pottery. ANON. *Crockery Glass Jour.*, **109** [11], 15–18 (1931).—The public has an opportunity of seeing at W. &. J. Sloane Co. a collection of contemporary work by Rookwood, Roseville, Cowan, Weller, Hull, Fulper, Aetco, Shearwater, Enfield, White Cloud Farms, and others. E.P.R.

Installing large art glass window. ANON. *Nat. Glass Budget*, **47** [31], 7 (1931).—A stained glass window 49 ft. high and 26 ft. wide, containing 59 medallions, and said to be the third largest window in the world is to be erected in a church in Pittsburgh. E.P.R.

Rose window for New York church. ANON. *Amer. Glass Rev.*, **51** [10], 33 (1931).—A rose window, larger than those in the cathedrals of Paris, will be erected by Charles J. Connick. E.P.R.

Modern tile from Italy. IRENE DI ROBILANTI. *House & Garden*, pp. 42–43 (Aug., 1931).—Modern tile can be used as wall coverings or as a substitute for pictures. Italian architects are finding that they can be used in many interesting ways to give spaciousness, color accents, and novel effects. (*D.I.*)

State Porcelain Manufacture at Berlin. ANON. *Deut. Kunst Dekoration*, pp. 67–69 (Oct., 1931).—Plastic ornamentation of porcelain as shown in the work of the State Porcelain Manufactury is described. Cache pots, hors-d'oeuvres dishes, and vessels to hold lily plants and bulbs are described. (*D.I.*)

National Majolika Manufactory of Karlsruhe. K. S. *Deut. Kunst Dekoration*, pp. 255–57 (July, 1931).—The National Majolika Manufactury at Karlsruhe has done a great deal in experimenting with new materials, glazes, and firing. It provides artists with the finest materials available and shows them new ways of using them. (*D.I.*)

Thirtieth anniversary of the National Majolika Manufactory of Karlsruhe. ANON. *Kunst*, pp. 240–43 (July, 1931).—An exhibition of the Majolika Manufactory at Karlsruhe in commemoration of its thirty years of establishment is described. A short historical résumé and pictures of some of the products are given. (*D.I.*)

Ceramic art in the city of Faenza. GIACOMO PAVONI. *Corriere Ceram.*, **12** [10], 419–23 (1931).—The school of ceramics with its museum and library at Faenza serves

to perpetuate the artistic traditions of this city and to foster the interest in ceramic art. Scientific and practical training are also offered. M.V.K.

Glassmaking in medieval Italy. F. URBANI DE GHELTOF. *Ind. Silicati*, 9 [9], 11 (1931).—In the early part of the 17th Century, Vincenzo Miotti of Murano discovered artificial aventurine while attempting to imitate agate and other precious stones in glass, thus starting a trade which still flourishes. The paste is usually an opaque cinnamon yellow glass dotted with brilliant gold-like spots, forms octahedrons of copper crystallized during the fusion and cooling of the glass mass, and is very difficult to obtain. See also *Ceram. Abs.*, **10** [11], 768 (1931). M.V.K.

Wedgwood replica of Portland vase. EDWARD ORTON, JR. *Bull. Columbus Gallery Fine Arts*, **2** [2], 4 pp. (1931).—A description is given of the Portland vase and of the only signed replica of it made to commemorate the 200th anniversary of the birth of Wedgwood. The latter now belongs to the Art Gallery. M.V.K.

Bowls from ancient Nubia. G. STEINDORFF. *Illus. London News*, **179**, 446–47 (1931).—Incised with "chessboard" and "chevron" patterns, the black-polished bowls of 2000 B.C. found at Anibe by S., working for the Egyptian Govt., are worthy of admiration even today. Illustrated. H.H.S.

Mosaic floors from a 6th Century monastery. G. M. FITZGERALD. *Illus. London News*, **179**, 530–31 (1931).—The Pa. Univ. Palestine Expedition at Beth-shean has uncovered mosaics. Illustrated. H.H.S.

American man contemporary with dinosaur. ANON. *Discovery*, **12**, 331–33(1931).—Gypsum Cave, Nevada, explored by the Carnegie Institution of Washington, has yielded human objects contemporary with prehistoric animal remains. H.H.S.

Barracks of Claudius at Colchester. J. P. BUSHE-FOX. *Times* [London], Sept. 22, 1931.—The Emperor Claudius defeated the British under Cymbeline in 43 A.D. The Colchester Excavation Committee has now unearthed his buildings and the remains of much pre-Roman history. H.H.S.

New discoveries at Knossos. ARTHUR EVANS. *Illus. London News*, **179**, 485–89 (1931).—The finding of a massive gold signet-ring by a boy in a Cretan vineyard has led to the discovery of a royal Minoan temple-tomb. 14 photographs. H.H.S.

BOOKS AND BULLETINS

Colour Science. W. OSTWALD. Authorized translation with an introduction and notes by J. S. Taylor. 141 pp. Windsor and Newton, Ltd., London, 1931. Reviewed in *Chem. & Ind.*, **50** [44], 879 (1931).—An account is given of the theory of color. The book has an excellent color diagram of standards of hue and other colored diagrams of the Ostwald color solid, isovalent circles, and semichromes. G.R.S.

Precious Stones. (Le pietre preciose.) U. MANNUCCI. 2d ed. Ulrico Hoepli, Milano, 1929. 401 pp. 27 illus. 40.00 lires. Reviewed in *Chim. & ind.*, **24** [3], 769 (1930).—In this enlarged edition, all the stones used in jewelry are classified and studied. The end of the book is devoted to synthetic precious stones and imitation stones which have no analogy in constitution with those they imitate. M.V.K.

Three Books on the Potter's Art. (I tre libri dell Arte del Vassaio.) CIPRIANO PICCOLPASSO DURANTINO. Reprinted in *Corriere Ceram.*, **12** [8], 329–35; [9], 383–89; [10], 423–27 (1931).—The last edition of this work of the great Italian ceramist was printed in 1879. It gives not only the technic and methods formerly used in the production of majolica, but also many secrets of the art still not generally known. The first book discusses (1) ways of obtaining sedimentary clays from the river beds, (2) methods of separating, filtering, and seasoning mined clay, (3) construction and operation of the turner's wheel, and (4) the making of objects of different shapes. M.V.K.

Delft Faience. (Delfter Fayence.) F. W. HUDIG. R. C. Schmidt, Berlin, 1929.

348 pp. 291 illus. 22.00 Rm. Reviewed in *Chim. & ind.*, **24** [2], 513 (1930).—This book is a part of the collection of the history of art "Bibliothek für Kunst und Antiquitätensammler." It is devoted to all ceramic products which can be grouped under the general heading, "Faience of Delft." It is illustrated by reproductions of magnificent faience pieces from museums and private collections, *e.g.*, Rijksmuseum, Bodenheim, Van Tijen, Enthoven of Amsterdam collections, and the museums of Bruxelles and Victoria Albert of London. The principal parts of the book deal with (1) Italian-Spanish decorations, 1570 to 1670, (2) the so-called Dutch faience proper, 1650, (3) Japanese and Chinese decorations, 1680 to 1760, (4) blue enamels on a white ground of the same period, (5) red tea services ornamented with flowering branches in relief (a kind of stoneware), (6) the second glaze "Kwaart," (7) influence of Saxony porcelain (muffle fired), and (8) development of colors of high firing and the so-called peasant or rustic faience. The book contains a list of all manufacturers and their different trademarks. See also *Ceram. Abs.*, **8** [6], 391 (1929). M.V.K.

Art in Industry. ANON. Verlag K. R. Langewiesche, Königstein and Leipzig, 1931. Price 3.30 Rm. Reviewed in *London Studio*, No. 462, 212 (Sept., 1931).—A collection of studies on industrial and mechanical subjects is reviewed. H.H.S.

Early Man: His Origin, Development, and Culture. G. ELLIOT-SMITH, A. KEITH, *et al.* 176 pp. 12 plates. Ernest Benn, London, 1931. Price 8s 6d. Reviewed in *Times Lit. Supp.*, **30**, 673 (1931). H.H.S.

Excavations at Dura-Europos. P. V. C. BAUR AND M. I. ROSTOVTZEFF. xix + 225 pp., 53 plates. Yale Univ. Press, New Haven, 1931. Price $3.25. Reviewed in *Times Lit. Supp.*, **30**, 696 (1931).—A report is presented of the second season of work by the Yale-French Academy expedition. See also *Ceram. Abs.*, **9** [5], 330 (1930). H.H.S.

Design and Mass Production. GREGOR PAULSSON. Design and Industries Assn., London. About 15¢. The director of the Swedish Arts and Crafts Society distinguishes between home crafts and mass production. He tells how Sweden has succeeded in reviving handicrafts and improving mass production. The alliance between the artist, designer, and manufacturer in Sweden is explained and advice is offered about the kind of designer to employ and the place he should properly be accorded in the manufacturing establishments. Decorative fallacies and the present status of industrial art are discussed. (*D.I.*)

Modern Swedish Decorative Art. NILS WOLLIN. Architectural Press, London, 1931. About $15. Swedish designers have been in the forefront of the modern design movement. This book is a résumé of the history of development of modern Swedish decorative art. It is illustrated with examples from all the branches of applied design. (*D.I.*)

PATENTS

Design for tumbler, etc. GEORGE SAKIER. U. S. 85,772, Dec. 15, 1931.

Design for plate, etc. FERDINAND POPPENHÄUSER. U. S. 85,621, Nov. 24, 1931. HOWARD A. LAY. U. S. 85,656, Dec. 1, 1931.

Design for goblet, etc. WILL CAMERON MCCARTNEY. U. S. 85,618, Nov. 24, 1931.

Design for jar, etc. RICHARD P. ENDERLIN. U. S. 85,690, Dec. 8, 1931. THEODORE J. PIAZZOLI. U. S. 85,712, Dec. 8, 1931.

Design for bottle. VINCENT P. DOLE. U. S. 85,689, Dec. 8, 1931.

Design for gas-stove casing. HENRY W. O'DOWD. U. S. 85,710 and 85,711, Dec. 8, 1931.

Design for gas or electric cabinet range. JACOB TELLER. U. S. 85,625, Nov. 24, 1931. JACOB TELLER AND ARTHUR P. SCHULZ. U. S. 85,626, Nov. 24, 1931.

Design for range. ALMER H. BRODBECK. U. S. 85,609, Nov. 24, 1931.

Design for set of range doors. ALMER H. BRODBECK. U. S. 85,610, Nov. 24, 1931.

Decoration of ceramic articles, e.g., glass, glazed porcelain, stoneware, etc. DEUTS. GOLD- UND SILBER-SCHEIDEANSTALT VORM. ROESSLER. Brit. 308,226, March 19, 1929; Ger., March 19, 1928. The articles are coated first with the color or luster in the usual way, then with solutions containing glycerol, chloral hydrate, or ethylene glycol, with colloids, *e.g.*, gum arabic, and, if desired, coloring materials. The top layer contracts on drying and heating and the lower layer is thereby caused to produce a network effect on the ware. (*B.C.A.*)

Cement, Lime, and Plaster

The alite problem. A. GUTTMANN AND F. GILLE. *Zement*, **20** [7], 144–47(1931); *Chim. & ind.*, **25** [6], 1434–35 (1931).—Optical, chemical, and X-ray studies definitely prove the existence of tricalcium silicate. This silicate is identical to alite, the essential constituent of Portland cement, is rich in lime, and must not be confused with the following mixtures: (1) a mixture of β-dicalcium silicate and lime (the position and intensity of certain lines being inconsistent with this hypothesis); (2) compound crystals of aluminate rich in lime or "Jäneckeite" and tricalcium silicate; (3) compound crystals of tricalcium silicate and tricalcium aluminate, the first substance having a greater importance; and (4) compound crystals of "Jäneckeite" and dicalcium silicate. The alumina of Portland cement rich in lime and poor in iron exists chiefly in the form of tricalcium aluminate. In normal clinker, the largest part of alumina is in the form of celite, especially the composition $4CaO \cdot Al_2O_3$ $(Fe,Mn)_2O_3$. The alumina surplus is found in the form of tricalcium and pentacalcium aluminate. The X-ray did not identify the Jäneckeite, $8CaO \cdot Al_2O_3 \cdot 2SiO_2$. The chemical composition of alite being established, it now remains to find its atomic structure and the process of its hardening. It is probable that these two questions are related to each other. For discussion see *Ceram. Abs.*, **10** [9], 624 (1931). M.V.K.

Hydrates of tricalcium aluminate. W. EITEL. *Zement*, **19** [17], 394–99 (1930); *Chim. & ind.*, **24** [3], 622 (1930).—A separate examination of the 3 main constituents of a cement (tricalcium silicate, dicalcium silicate, and tricalcium aluminate) showed that tricalcium aluminate plays the most important rôle when cement is attacked by sulphates. Several hydrates were isolated from the $CaO \cdot Al_2O_3 \cdot H_2O$ system. The first has the formula $3CaO \cdot Al_2O_3 \cdot 7H_2O$. The most important, obtained by the action of steam at 150°C on very pure tricalcium aluminate (free from uncombined lime), corresponds to the composition $3CaO \cdot Al_2O_3 \cdot 6H_2O$. It is optically isotropic and crystallizes in the regular system; it is quite stable, but at 250°C it loses water and changes into inferior hydrates. Tricalcium aluminate produces other superior hydrates which crystallize in the sexagonal system. They are formed at 25°C in the presence of large quantities of water but are not very stable. At a low temperature it is possible to isolate hydrates with 12, 10.5, and 8 molecules but these substances decompose forming hexahydrates. The immunizing action of water in cements treated with superheated steam can be explained by the transformation of superior hydrates into hexahydrates and by a reaction of the free lime on silica and some other constituents of cement. M.V.K.

Decomposition of tricalcium silicate in the temperature range 1000 to 1300°C. E. T. CARLSON. Bur. Stand., *Jour. Research*, **7** [5], 893–902 (1931); R.P. 381.—Tricalcium silicate tends to dissociate into dicalcium silicate and lime when heated to temperatures between 1000°C and 1300°C. The amount of decomposition reaches a maximum at about 1175°, being about 15 times as great at this temperature as at 1000°

after a day's heating. The reaction is accelerated by the presence of either of the products of decomposition, *i.e.*, dicalcium silicate or free lime. Tricalcium silicate which has been exposed to moist air decomposes much more readily than when freshly calcined, probably owing to the presence of lime liberated by the action of moisture on the silicate. The presence of gypsum also accelerates the decomposition. This may be due to lime liberated by dissociation of the gypsum. R.A.H.

Mineral formations from fused kaolin-lime mixtures. I. WEYER. *Zement*, **20** [12], 264–65 (1931).—Different metakaolin and lime mixtures were fired to 1450 ± 10° for 5 and 6 hr. In mixtures with less than 9 mol. CaO, dicalcium silicate appeared in the unstable β-modification; the stable modification could not be observed. In mixtures with more than 9 mol. CaO dicalcium was no longer observed but tricalcium silicate appeared in completely formed crystals. The determination of their optical data was difficult as the crystals of tricalcium silicate were imbedded in tricalcium aluminate. Their refraction of light is the same as that of a pure tricalcium silicate. A mixture of metanacrite and 10 CaO fired for 1 hr. to 1650 ± 10° contained small quantities of dicalcium silicate present in the γ modification. For the first time isolated crystals of the stable modification of pentacalcium trialuminate were determined. With longer firing, the optical data of tricalcium silicate did not change. At temperatures of 1700 ± 10°, the same results were found; the 2 compounds $3CaO \cdot Al_2O_3$ and $3CaO \cdot SiO_2$ were present. The mixture fired at 1700° was röntgenographically investigated. Besides CaO, the diagram contained only the lines of tricalcium aluminate and tricalcium silicate. M.V.K.

Degree of lime saturation. HANS KÜHL. *Zement*, **20** [6], 123–25 (1931); for abstract see *Ceram. Abs.*, **10** [8], 544 (1931). M.V.K.

Relations between analysis and strength of cements. H. LUFTSCHITZ. *Tonind.-Ztg.*, **55** [92], 1276–78 (1931).—A diagram is given for different cements the abscissa of which is the ratio of resistance to pressure and tensile strength; the ordinate is the strength itself. Curves are of a wave-like form which are also extrapolated. L. points out that these curves generally show a relation between analysis and strength of cements. W.M.C.

Analysis of standard cements. H. BURCHARTZ. *Zement*, **20** [12], 258; [13], 290–92 (1931).—According to German standards for Portland cement, iron-Portland cement, and blast-furnace cement, the following factors must be ascertained by analyses: (1) loss on ignition, (2) insoluble residue, (3) soluble silica, (4) the amount of oxides of alumina (Al_2O_3) + iron (Fe_2O_3) + manganese (Mn_3O_4) (abbreviated: indicated as R_2O_3), (5) lime (CaO), (6) magnesia (MgO), and (7) sulphuric anhydride (SO_3). The investigation can be completed by ascertaining the content of (8) alumina (Al_2O_3), (9) iron oxide (Fe_2O_3), (10) manganese oxide, (11) sulphuric sulphide (S), and (12) alkalis. The proportion by weight of lime in Portland cement to the amount of soluble silica (SiO_2) + alumina (Al_2O_3) + iron oxide (Fe_2O_3) is calculated according to the formula $\frac{\%CaO - \%SO_3 \times 0.7}{\%SiO_2 + \%R_2O_3} \geq 1.7$. Data on the concentration of solutions and reagents are given and all separate processes are described in detail. M.V.K.

Influence of storing on properties of standard cement. K. GRÜN AND H. MANECKE. *Zentr. Bauverw.*, **50**, 485 (1930); *Zement*, **20** [4], 86 (1931).—The results of (1) cold, (2) house, and (3) shed storage of standard cement are given. These results agree with those undertaken previously. M.V.K.

Chemical composition of cement. K. K. AALTO. *Acta Chem. Fennica*, **4**, 26–34 (1931).—A review is given of the work by Le Chatelier, Jörgensen, Zulkowsky, Duchez, and others on the composition of cement with explanatory notes on the triangular coördinate systems used for the system $CaO \cdot SiO_2 \cdot Al_2O_3$. A. criticizes the work since

their formulas do not take into account the constituents of Portland cement that are found in graphs determined by Rankin and Erculisse. He supports the formula given by Erculisse, $(Al_2O_3 \cdot 3CaO)p \cdot (SiO_2 \cdot qCaO)$, although it does not explain the formation of the aluminate, $5CaO \cdot 3Al_2O_3$. Portland cements differ in the values for p and q; hence the composition varies from $Al_2O_3 \cdot 3CaO$ to $SiO_2 \cdot 2CaO$ and $SiO_2 \cdot 3CaO$, but in such a way that the chemical analysis agrees with the above formula. See also *Ceram. Abs.*, **9** [7], 502 (1930). (*C.A.*)

Control devices for supervising cement manufacture. OTTO SCHOTT. *Zement*, **20** [18] 408–14; [20], 469–72 (1931).—The latest devices used for obtaining raw materials, for drying installations, for grinding, for kilns, dusting-off installations, steam-boiler operation, and steam-power machines are discussed. M.V.K.

Reasons for setting disturbances in alumina cement. H. W. GONELL. *Zement*, **20** [8], 164–68 (1931).—On the basis of his investigations, G. concludes that the carbonic acid from the air causes the setting disturbances in the alumina cements investigated. M.V.K.

Acid-proof cement. U. S. STONEWARE CO. *Metal Cleaning & Finishing*, **3** [11], 924 (1931).—"Pre-mixt" acid-proof cement is used in the same manner as Portland cement. E.J.V.

Manufacture of Portland cement. H. GUTTERIDGE. Abstract of paper presented to Inst. of Structural Engineers. *Mech. World*, **90** [2342], 501 (1931).—G. gives a layman's description of the making of Portland cement. E.P.R.

Portland cement from raw materials containing magnesia. WALTER MARSCHNER. *Zement*, **20** [12], 265–66 (1931); this is a correction on reference given in *Ceram. Abs.*, **10** [7], 482 (1931). M.V.K.

Bauxite for "ciment fondu." ANON. *Chem. Trade Jour.*, **89** [2308], 155 (1931).—Data on the French bauxite industry are given. Thirty per cent of this industry is absorbed for manufacturing ciment fondu. The red bauxite used for this product contains about 40 to 50% alumina. Ciment fondu has several advantages over other cements, the principal ones being the rapidity with which the initial setting takes place and the high initial resistance and nondecomposition in sulphatic and sea water. Another peculiarity of ciment fondu is its indifference to temperature in the matter of setting, having been used at 12° below zero C, and in Morocco with a temperature of 52° over zero C, and in both cases showing excellent results. See also *Ceram. Abs.*, **10** [10], 708 (1931). M.V.K.

Arsenious cement of low solubility. DONOVAN WERNER AND STIEG GIERTZ-HEDSTRÖM. *Zement*, **20** [17], 384–88 (1931); note correction of reference given in *Ceram. Abs.*, **10** [11], 754 (1931). M.V.K.

New ways of cement manufacture in the U.S. CARL NASKE. *Zement*, **20** [12], 266–68; [13], 292–96 (1931).—Several American cement plants are described. M.V.K.

American cement industry. C. R. PLATZMANN. *Zement*, **20** [6], 135–36 (1931).—P. describes the achievements of the cement industry in the U.S. M.V.K.

Effect of grinding on setting time of cement. K. KOYANAGI. *Zement*, **20** [20], 467–69 (1931); note correction of reference given in *Ceram. Abs.*, **10** [10], 680 (1931). M.V.K.

Processing Canadian gypsum. C. J. S. WARRINGTON. *Can. Chem. Met.*, **15** [11], 31–33 (1931).—The rapid rehydration of the hemihydrate of calcium sulphate to form a rigid, interlocking mass of crystals of the original calcium sulphate dihydrate from which the "plaster" was derived, has been proved by recent kinephotomicrography to consist in re-solution of the hemihydrate in water and subsequent crystallization of the gypsum. E.J.V.

PATENT

Producing a hydraulic aluminous binding material and an iron alloy. LEONCE DE LAMBERT. U. S. 1,834,770, Dec. 1, 1931. Process for producing hydraulic aluminous cement and an iron alloy by-product comprising reducing the fusion temperature of a charge of ferriferous bauxite and limestone in substantially equal proportions and slightly less than 100% of the entire mixture, by adding thereto a relatively small proportion of phosphorus material, effecting the chemical reduction of the iron oxides in the mixture for the purpose of improving the character of the iron alloy by-product by adding to the mixture a relatively small proportion of a carbonaceous reducer, fusing the mixture at the reduced temperature thus made possible, and while still fluent, effecting the separation of the cement material from the iron alloy.

Book Review

Materials for Standardization of Building Materials. Cement Industry. SUPREME COUNCIL OF PUBLIC ECONOMY, U.S.S.R. Vol. I. State Technical Publishing House, Moscow, 1930. 167 pp. Price 2R 60 k. This book contains valuable data relating to the standardization of cement substances. In the first part, standards adopted in the U.S.S.R. on cements, limes, and stucco gypsum (plaster) are described and nine new projects of standards are outlined and discussed. SELICK I. PERKAL

Enamels

Removing an enamel. I. ANON. *Emaillewaren-Ind.*, **8** [44], 55–56(1931).—There are several ways of removing enamel from an object: (1) by repeatedly heating and immersing the object in cold water till the enamel is removed, (2) by removing the enamel with a sand jet, and (3) by dissolving it in liquids. Removing an enamel with a sand jet is simple but has great disadvantages as it is expensive and can be used only for objects having a solid metallic base and a simple shape. The removal of an enamel by means of chemicals is much cheaper and the results obtained are more satisfactory. (1) A 25% sulphuric bath is heated to 60° and the object is immersed. The bath is heated for 1 hr. and left to cool. The hot sulphuric acid attacks the enamel and during cooling dissolves it completely. It is important that the hot acid does not attack the iron and therefore it should not be heated more than necessary. Cold acid does not affect the metal so much but it continues to dissolve the enamel. This method gives good results. It is important to determine the best concentration of the acid according to the hardness and thickness of the enamel. (2) The method of using fluorhydric acid is simpler. The bath need not be heated because fluorhydric acid is much stronger and completely dissolves silica. Enamel composed of silicates is rapidly corroded by the acid. Another advantage of fluorhydric acid is that it affects iron only slightly. Vielhaber studied the question of the formation of silica fluoride gas during the removal of the enamel by fluorhydric acid and found that the quantities of gas formed are very small. The following reactions take place: $12HF + 3SiO_2 = 3SiF_4 + 6H_2O$; and $3SiF_4 + 4H_2O = H_4SiO_4 + 2H_2SiF_6$. HF dissolves SiO_2 and SiF_4 and water are formed. SiF_4 immediately reacts with water and produces H_4SiO_4 and H_2SiF_6. The latter reacts with soda, always present in the bath, and forms Na_2SiF_6 which remains insoluble in water together with silicic acid. M.V.K.

Researches on the adhesion of enamels. ANON. *Glashütte*, **61** [17], 304–306 (1931); *Chim. & ind.*, **26** [4], 876 (1931).—To enamel sheet iron it is necessary to cover it with a thin coat of ground enamel containing cobalt oxide or nickel oxide. Only such an enamel adheres to the metal and permits the coating of an external colored enamel.

The adherence seems to be due to a physical phenomenon, the "wetting" capacity of the enamel depending on the surface tension, and to a purely chemical action, the rôle of oxygen during firing. It is certain that the enamel "dissolves" the oxygen, that the layer formed does not disappear when the enamel adheres as it combines with the iron oxide of the sheet, and that these two films produce the adherence desired. During firing when the enamel is melted, the oxygen from the air can no longer penetrate to the sheet. This oxygen which must be present during firing must be freed hot by the oxides of cobalt and nickel in contact with the iron. If other materials are substituted for these two oxides, they must react in the same way, *viz.*, they must have multiple valences and degrees of oxidation. M.V.K.

Enameling casts. ANON. *Emaillewaren-Ind.*, **8** [22], 25–26; [26], 32; [31], 38 (1931).—The process of enameling cast iron is discussed. The firing of the fritted mass takes place between 750° and 850° according to the properties and hardness of the enamel. After firing, the mass on the cast should be opaque and of a white color, sometimes yellowish. If it is lustrous, it is a sign that it has been fired too rapidly. The yellow color may be produced by iron oxide or rust. Practice shows that the success of enameling casts depends on the treatment of the frit. Its chemical composition is not so important; the main requisite is that it be difficultly fusible. The preparation and composition of enamels for casts is similar to that of enamels for sheet metal. Antimony oxide is usually used instead of zinc oxide and the content in opacifiers is lowered to obtain less expansion. M.V.K.

Enameling of cast metal. J. H. D. BRADSHAW. *Bull. assn. tech. fonderie*, **5**, 159–64 (1931); for abstract see *Ceram. Abs.*, **9** [9], 715 (1930); see also following abstract. (*C.A.*)

Enameling cast iron. J. H. D. BRADSHAW. *Usine*, June, 1931; *Giesserei*, **18** [28], 572 (1931); for abstract see *Ceram. Abs.*, **9** [9], 716 (1930). M.V.K.

Enameling iron objects. J. BORDEGE. *Ind. chim.*, **17** [197], 410 (1930); for abstract see *Ceram. Abs.*, **10** [4], 255 (1931). M.V.K.

Obtaining white ground coats on iron. A. KREIDL. *Emailletechnische Monats-Blätter*, **6**, 179–81 (1930); *Giesserei*, **18** [2], 51 (1931).—The process is based on the fact that the viscosity of an enamel is increased by the addition to a ground enamel of water-insoluble compounds of alkaline earths and an increase in the clay content, and that the usual amount of opacifier, *e.g.*, tin oxide, can be added directly to a ground enamel. The opacifier is not dissolved at the ordinary firing temperatures used. M.V.K.

Constitution and formation of phosphide eutectic in cast iron. MARTIN KÜNKELE. *Giesserei*. **18** [4], 73–78; [5], 94–98 (1931).—K. describes researches on gray-iron castings. M.V.K.

Applying enamel with compressed air. VIELHABER. *Emaillewaren-Ind.*, **8** [35], 274–75; [36], 286–87; [37], 293–94; [38], 303–304; [42], 333–35 (1931).—The enameling of different objects by means of compressed air is described. M.V.K.

Attachment for the compressed air and feeding pipes in an enamel-spraying apparatus. ANON. *Emaillewaren-Ind.*, **8** [44], 349–50 (1931).—A new device used in spraying apparatus which decreases the amount of compressed air consumed is described. It increases the lifetime of the rubber pipes and at the same time makes the spraying more efficient. M.V.K.

Obtaining mat enamels. ANON. *Anz. Berg.-Hütten.-Maschinenwes.*, March, 1931; *Giesserei*, **18** [23], 472 (1931).—Mat enamels are obtained by combining large quantities of alumina-containing ingredients such as clay, kaolin, or feldspar with small quantities of enamel. The method developed by the German Gasglühlicht-Auer-Co. is described. M.V.K.

Acid-resisting, dry-process, cast-iron enamels and the effects of BaO, PbO, and ZnO. L. D. FETTEROLF. *Jour. Amer. Ceram. Soc.*, **15** [1], 1–7(1932).

Relation of coefficient of expansion to cross-bending strength of sheet-steel enamels. MURRAY C. GAUTSCH. *Jour. Amer. Ceram. Soc.*, **15** [1], 8–12 (1932).

Effect of furnace gases on quality of enamels for sheet steel. A. I. ANDREWS AND E. A. HERTZELL. *Metal Cleaning & Finishing*, **3** [11], 906 (1931); for abstract see *Ceram. Abs.*, **10** [9], 628 (1931). E.J.V.

Using calcium fluoride in enamels. H. LANG. *Keram. Rund.*, **39** [18], 163–64 (1931); *Chim. & ind.*, **26** [4], 573 (1931).—It was thought that calcium fluoride affects the enamel but as present investigations show, it is advantageous to use enamels containing up to 15% calcium fluoride. (1) This substance lowers the fusing point of an enamel when it is present in a quantity $^2/_3$ of that of the cryolite eventually present. (2) The fluoride acts as an opacifier in enamels without cryolite; in others, it has no action. The simultaneous presence of antimony (small quantity) and calcium fluoride produces the only classical opacity of white enamels. Enamels containing CaF_2 are better and less breakable, the less sodium carbonate they contain; the latter may be replaced by borax. (3) Calcium fluoride improves the adherence of an enamel. M.V.K.

Studies on enameling agents. II. T. UCHIDA. *Repts. Osaka Imp. Ind. Research Inst.* [Japan], **12** [6], 240 pp. (1931); for Part I see *Ceram. Abs.*, **8** [10], 712 (1929); see following abstract. (*C.A.*)

Study of enamel glaze. T. UCHIDA. *Proc. World Eng. Cong.* [Tokyo, 1929], **31**, 316–73 (1931).—The influence of the various chemical components of an enamel glaze on the luster, opacity, crawling, blistering, cracking, and adherence on plates of Cu, cast Fe, steel, and steel with a coating of ground enamel were determined. (*C.A.*)

Relation of fineness of feldspar used in compounding a porcelain enamel to resistance to deflection. RICHARD H. TÜRK. *Jour. Amer. Ceram. Soc.*, **15** [1], 13–16 (1932).

Enamel opacity. ANON. *Ceram. Ind.*, **18** [6], 471–72 (1931).—The relative values of thickness of enamel and of opacifiers are discussed. Opacifiers are relatively high in cost but increasing the thickness of the enamel is also expensive. This increase in thickness causes a tendency toward chipping and decreases the resistance to mechanical shocks and strains. In one enamel it required a 125% increase in thickness to increase the opacity 27%. It has been shown that by increasing the opacifier from 4 to 8% the thickness of enamel necessary to give a reflection factor of 70 is decreased from 0.0167 to 0.0106 in. W.W.M.

Avoiding formations of bubbles in enameled welded hollow ware. ANON. *Emaillewaren-Ind.*, **8** [41], 327–28 (1931).—When a surplus of enamel is deposited, cracks and bubbles form. The surplus can be removed with a long needle. The enamel must be well dried and with every coating it should be scraped with the needle; the welded seams should also be kept clean. M.V.K.

Testing methods for enameled objects. KARMAUS. *Emaillewaren-Ind.*, **8** [37], 294–95; [38], 301–303; [39], 309–10; [40], 317–18; [41], 325–26 (1931).—K. discusses different methods used for testing enameled objects: (1) The mechanical strength is determined by the test of the falling ball; the sizes for steel balls for cast enamels and sheet enamels of different thicknesses are given. (2) The thermal capability of resistance of enameled objects shows that the tensions in the object and in the enamel are equal during changes in temperature. Different methods for testing the thermal resistance are described. (3) There are no exact and rapid methods for testing the gloss of opacification and of the color tones. (4) Cooking utensils and enameled objects may be divided into 3 categories as follows: (*a*) stable to cooking acids, (*b*) acid-proof, and (*c*) highly acid-proof (there is a difference between acid-proof and acid-resis-

ting enamels in the U.S.). Highly acid-proof enamels are used only in chemical apparatus. (*a*) Tests with 10% acetic acid for enameled cooking utensils are explained. Enamels resistant to alkaline influences are tested in the same way but instead of acetic acid, a 10% soda solution is used. (*b*) Acid-proof enamels are also tested in the same way with 10% hydrochloric acid. (*c*) Highly acid-proof enamels are tested according to their use. A boiling test of 100 hr. with different acids of different concentrations may be used. The best method for testing flat-enameled objects as parts of hearths, kilns, etc., is the method of Keppeler (see *Ceram. Abs.*, **7** [11], 750 (1928)) which is also described. M.V.K.

Electric heat for the metal industries. J. C. WOODSON. *Elec. World*, **98** [23], 1004–1007 (1931).—The need for bright annealing in artificial atmospheres of sheet iron for vitreous enameling is pointed out. G.R.S.

Theory of annealing cast iron according to American processes. H. HEKKER. *Giesserei*, **18** [1], 14–19; [2], 39–45 (1931).—H. discusses (1) requirements for annealing, (2), errors and their causes, and (3) new processes used. M.V.K.

Modern metal cleaning. ANON. *Metal Ind.* [London], **38** [7], 191–92 (1931).—The use of "Vienna lime," a product prepared by firing dolomite or limestone of high magnesia content, and silicate of soda for cleaning metal is discussed. M.V.K.

Metal cleaning system. REX PRODUCTS & MFG. CO. *Ceram. Ind.*, **17** [6], 484 (1931).—A hot solvent process for cleaning metals and alloys is known as the S-M System and employs a cleaning liquid bearing the name Perm-A-Clor. The process is described. W.W.M.

New process of metal cleaning. MACKENZIE MFG. CORP. *Metal Cleaning & Finishing*, **3** [11], 921 (1931).—A new process has been made possible, partially by triethanolamine, an organic base, certain compounds of which have exceptional emulsifying properties. The compounds of triethanolamine known as "Emulso Primer" Nos. 1, 2, 3, etc., give emulsification, colloidal suspension, deflocculation, and free rinsing to the cleaning solution. Other features of the process are described. E.J.V.

Equipment for cleaning metal. XI. R. W. MITCHELL. *Metal Cleaning & Finishing*, **3** [11], 869–74 (1931).—Various systems and devices used for controlling temperatures in the various tanks are described and discussed. Illustrated. For Part X see *Ceram. Abs.*, **11** [1], 12 (1932). E.J.V.

PATENTS

Enamel containing barium and strontium compounds for the enameling of metal. LOUIS ERNEST MIGEOT. U. S. 1,833,087, Nov. 24, 1931. A composition for enameling metals by sprinkling upon a first coating of opaque white enamel, the use of a transparent or translucent enamel free from lead, essentially consisting in a mixture of borax 21%, boric acid 11.25%, baryta 25%, feldspar 8.75%, alkalis 11%, lime 11.50%, zinc 10%, and alumina 1.5%.

Swinging cover for top burner portion of stoves. ARTHUR STOCKSTROM. U. S. 1,833,760, Nov. 24, 1931. The combination with a gas range having a top burner portion, a protecting swinging cover provided with a flange extending partly around the burner portion, the inner ends of the flange pivotally supported by the structure, an outer flange adapted to telescope the outer wall of the open burner structure when the parts are raised, and the inner side flange cut away from a point below the burner portion whereby the parts operate as described.

Tiled wall. OWEN E. GRIGSBY AND GEORGE D. HAINES. U. S. 1,836,964, Dec. 15, 1931. A tiled wall comprising, in combination, a rigid foundation sheet constituting a part of the wall and having projecting portions forming pockets on its face, and rigid tile cemented to the sheet and fitting within the pockets with the projecting portions

closely surrounding the tile, the tile projecting above the projecting portions, whereby grooves are formed between adjacent tile, part of the cement being forced between the projecting portions and the sides of the tile when the tile is set in place.

Manufacture of translucent enamels for cast-iron and sheet metal by the powdering process. MIGEOT FRERES. Brit. 360,309, Nov. 11, 1931.

Glass

Measuring thermal conductivity of glasses. R. LEULOS. *Rev. Optique*, **10** [6–7], 266–72 (1931); *Sprechsaal*, **64** [45], 836 (1931).—The method is based on the principle that a plate of unknown thermal conductivity is put on a plate of a known thermal conductivity; a reduction of temperature is produced in both plates and the partial falling off in temperature of both plates is determined separately. The formula used is $x = c \cdot \frac{t_3 - t_2}{t_2 - t_1} \cdot \frac{e_1}{e_2}$ where x is the value to be determined, c is the known thermal conductivity of the comparison material, t_3 and t_1 give the total fall of temperature (steam of about 100° and running water of about 15°), t_2 is the temperature between both plates, and e_1 and e_2 are the thicknesses of plates in cm. The mode of procedure was as follows: The plate to be investigated and of a known thickness (e_2) was deposited over the comparison body (e_1); a copper plate of 5 mm. thickness was put between the two plates. The heat source (a current of steam of about 100°) was put over the plate to be tested and separated from it by a copper plate; under the comparison body, also separated by a copper plate, was a stream of rapidly running cold water (about 15°). The three temperatures of the copper plates were measured (t_1, t_2, t_3) with the use of three copper constant thermoelements after the appearance of heat equilibrium in the system (15 min.). The eventual errors through the copper plates were disregarded as these conduct from 500 to 1000 times better than the materials to be investigated. Water was taken as a comparison material with a known heat conductivity ($c = 14.10^{-4}$ units in c.g.s.) to which about 3% starch was added to avoid convection streams. The addition of starch made practically no change in the thermal conductivity figure as the tests showed. Measurements on a Saint-Gobain glass gave 0.0018 c.g.s., for Pyrex glass, 0.0023 c.g.s. This method is convenient and permits the investigation of small samples. M.V.K.

Fusion of sulphate glass. DUEFFE. *Ind. Silicati*, 9 [10], 13–14 (1931).—Carbon in some form is added to sulphate glasses to bring about the separation of Na_2O and the volatile SO_3 of the sodium sulphate. The formation of the "gall" in such batches is explained and ways of eliminating it are given. Notes on the coloring and whitening of sulphate glasses are also given. This subject is discussed in detail by Ludwig Springer (*Sprechsaal*, Nos. 28 to 32 (1916)). M.V.K.

Ammonium salts as fluxes and refiners in the glass industry. LEOPOLDO BUATIER DE MONGEOT. *Ind. Silicati*, 9 [10], 12 (1931).—Results of tests to determine whether ammonium salts can be used as fluxes and refiners in the glass mass are as follows: (1) Ammonium salts generally aid the fusion but not all to the same extent. The chloride, carbonate, nitrate, nitrite, and acetate when mixed and added to the batch have no refining action. (2) The sulphate and phosphate of ammonium have a higher fluxing and refining power. (3) The quantity of sulphate and phosphate to be used should not exceed 2 kg. per 100 kg. of sand; a greater quantity is unnecessary. (4) If the glass to be refined contains from 15 to 20% lime, ammonium phosphate sometimes produces opalescence. Later practical tests with ammonium sulphate confirmed these results and showed sufficient agreement with Parkin, Warren, and Turner (see *Ceram. Abs.*, **10** [10], 684; [12], 832 (1931)) and Vickers, Whiting, Miller, and Bates (see

Ceram. Abs., **10** [10], 684 (1931)). It was further determined that (1) the fluxing action of ammonium sulphate increases with an increase in the per cent of lime in the glass to be fused. (2) The addition of ammonium sulphate increases the loss of boric acid, thus diminishing the per cent of boric anhydride in the glass. (3) No appreciable influence on the working period of the glass was observed. M.V.K.

Sodium silicate as an accelerator in glassmelting. I. I. KITAIGORODSKY AND H. V. SOLOMIN. *Zhur. Prikladnoi Khim.*, **6** [2–3], 213–18 (1931); for abstract see *Ceram. Abs.*, **10** [12], 832 (1931). M.V.K.

Potassium acetate in the glass industry. CHARLES H. BUTCHER. *Chem. Trade Jour.*, **89** [2308], 151 (1931).—Potassium acetate is used in the manufacture of crystal glass partly for the purpose of "finning" the molten glass. "Finning" is a process by which exceedingly small bubbles of gas remaining enmeshed in the molten glass are removed by liberating larger bubbles of gas beneath the surface so that these bubbles in rising will drag the smaller bubbles with them. In ordinary glassmaking practice, organic matter such as potatoes, beets, and pieces of moist wood are used as finning agents, because when these are plunged into the molten glass they rapidly gasify and leave very little residue. Potassium acts in much the same way but the metallic oxide produced by heat decomposition enters into the composition of the glass leaving no residue. M.V.K.

Glass of high chemical and thermal resistance. ANON. *Econ. Rev. Soviet Union*, **6** [22], 523 (1931).—This glass requires no potash and reduces alkaline content by 40%. The chemical resistance of this glass is not inferior to the best grades manufactured outside of the U.S.S.R. and the glass is cheaper. M.V.K.

Fundamentals in glass technology. II. Properties desired for a glass mixture. Edited by GEO. V. MCCAULEY AND C. D. SPENCER. *Ceram. Ind.*, **17** [6], 474–76 (1931).—Commercial glass compositions vary within narrow limits. Chemical classification and the uses of various kinds of glasses are given. Microchemical and other tests for determining the components of an unknown glass are described. Stability and crystallization tendencies of glasses are discussed. A partial bibliography on devitrification is given. For Part I see *Ceram. Abs.*, **10** [11], 763 (1931). W.W.M.

Ultra-violet situation. M. LUCKIESCH. *Elec. World*, **98** [19], 829–32 (1931).—Typical spectrograms and graphs are given of some of the special characteristics of sources of ultra-violet radiation of glass and of the sensitivity of the eye and of the skin. G.R.S.

Researches with a dilatometer on the glass state. O. KOERNER AND H. SALMANG. *Z. anorg. allgem. Chem.*, **199** [3], 235–40 (1931); *Sprechsaal*, **64** [36], 668 (1931).—The theory that glass is a fourth state of matter (E. BERGER, *Ceram. Abs.*, **7** [4], 222 (1928); **10** [8], 550 (1931)) is based on the fact that all the physical properties of glasses change with heating or cooling. Dilatometric researches show that the transformation point appears only when strained glass is rapidly heated (about 5° per minute). Glasses practically free from tensions when heated slowly (about 10° per hr.) show rectilinear tension curves without the smallest indication of a transformation point. The softening point of glasses heated slowly was considerably below the softening temperature of glasses heated rapidly. Moreover, softening could be obtained by keeping the temperature far below the transformation point for a long time. The transformation point in strained glass heated rapidly is ascribed to a sudden adjustment of the tensions. Two kinds of tensions are distinguished: (1) those produced by sharp cooling and observed by double refraction and (2) those which appear with proportionally slower cooling and which affect the phenomena of the devitrification and transformation. As expansion of crystals at the point of conversion does not depend on the velocity of heating, it is unnecessary to consider the transformation point as a conversion point. It can be

conceived as an overheating or undercooling phenomenon. Further, glass is regarded as an undercooled liquid. M.V.K.

Neodymium and praseodymium in glass manufacture. RENATO METALLI. *Ind. Silicati*, **9** [9], 17 (1931).—The use of the rare earths, neodymium and praseodymium in glass manufacture was studied by Weidert (see *Ceram. Abs.*, **8** [11], 800 (1929); **9** [1], 20 (1930)). By means of small additions of these two metalloids and their salts, it is possible to obtain a glass which changes color according to its thickness, the source and power of light, and the position of the observer, thus creating a remarkable play of colors. Objects seen through this glass appear much more plastic and saturated with color than the rough ordinary glass and by means of it an entirely monochromatic light can be produced which is of maximum importance for optical, chemical, and physical measurements. See following abstract. M.V.K.

Using rare earths in the manufacture of special glasses. ANON. *Ind. chim.*, December, 1929; **17** [197], 410–11 (1930).—Cerium gives glass the property of being opaque to ultra-violet rays. Glass containing neodymium is manufactured for lamps using mercury vapor and is also used for obtaining artistic and artificial precious stones. The glass color depends on the occurrence of light, as a glass containing praseodymium is green in natural light and colorless in the light of a candle. See also *Ceram. Abs.*, **9** [12], 1033 (1930). M.V.K.

Effect of alumina content of glass on the degree corrosion of grog material of glass furnaces. P. P. BUDNIKOFF, G. V. KUKOLEV, AND I. S. SMELJANSKY. *Glastech. Ber.*, **9** [3], 144–48 (1931).—A survey is given of the existing literature on the chemical composition and physical properties of glass and the corrosion of the fire brick, indicating that increased alumina content of the glass protects the brick from deterioration. Experiments have been carried out using brick of the following formula: SiO_2 60.66%, $Al_2O_3 + Fe_2O_3 + TiO_2$ 37.71%, CaO 1.49%, and MgO 0.14%. Its water absorption is 13.76%, apparent porosity 25.63%, density 1.86, compressive strength 182 kg./sq. cm., shrinkage after three hours at 1450°, 1%, and deformation under a load of 2 kg./sq. cm. at 1480°, 20%. Samples 70 x 70 x 70 mm. have been used, into which a cylinder 4 cm. in diameter and 35 cm. long has been drilled. The batch was then pressed into the opening and the material was heated in the Kryptol furnace. After cooling, samples were cut and the corrosion of the cylinder was ascertained by comparing the cross-section of the hole with samples in the blank experiment without batch. Mixtures such as are used for white bottles in the Lynch machine as well as for soda-lime glass with and without alumina content, have been used with the following results: The cross-section of the cylinder increases up to 23% under the action of the alumina-free soda-lime mixture, whereas the same mixture with 5% clay gives an increase of only 3.5%. Even at higher temperatures the corrosion is less if alumina is added than at low temperatures with alumina-free mixtures. An introduction of 1.5 to 2.5% alumina is recommended to improve the melting and working of the glass. For white glass, alumina should be introduced in the form of feldspar; for green glass, in the form of trachyte or andesite. K.L.-H.

Use of barium oxide to study flow of glass in tank furnaces. W. M. HAMPTON. *Jour. Soc. Glass Tech.*, **15** [59], 251–55 (1931).—Equations are given for finding the concentration of a constituent at any time when the constituent is (1) initially absent from the tank but is introduced in the frit, (2) initially present in the tank and is removed from the frit, and (3) initially present in the tank and is introduced in a new concentration in the frit. The experiments and theoretical discussion agree in emphasizing the importance of convection in the tank in promoting uniformity of composition and the diffusion occurring at week-ends shows that there is a marked direct flow during ordinary working conditions. G.R.S.

System for finding strains in glass. RENÉ LEONHARDT. *Amer. Glass Rev.*, **51** [7], 15–16 (1931); for abstract see *Ceram. Abs.*, **10** [4], 261 (1931). E.P.R.

Bubbles and streaks in the glass melt. H. JEBSEN-MARWEDEL. *Sprechsaal*, **64** [47], 868 (1931).—Bubbles in the glass melt are the principal means of obtaining its homogeneity, but if they are not removed at a certain stage they appear in the finished product as defects. With a knowledge of the reasons for the appearance of streaks, this other defect can be eliminated. Both defects, bubbles and streaks, are more closely related than has been thought. The mechanism of reactions of both phenomena is described in detail. The appearance of bubbles in the melting batch up to their escape from the melt is shown in photographs. It is also observed that a contact between different glass layers may result from the formation of bubbles and that the process of dissolution of refractory materials is related to it. This process appears in the pictures. The streaks are inseparably connected with the regular phenomenon of streaming in the melt. Their origin is also discussed. The part that the refractory materials play in the formation of streaks is pointed out. The investigation is supported mainly by illustrations made by an especially arranged photographic apparatus. M.V.K.

Corrosive action of glues on glass. HUGO KÜHL. *Glashütte*, **61** [22], 402–403 (1931); *Chim. & ind.*, **26** [4], 875 (1931).—The corrosive action exerted by colloidal glues or mastics on glass is due to the chemical affinity of the glue constituents for the constituents of the glass. Acids and especially alkalis attack glass and certain glues have an acetic, caustic lime, or alkali base. Immediately when the glass surface is attacked chemically, the action of colloidal glue is increased because its particles penetrate the microscopic fissures and pores of the glass mass. The adhesion increases at the same time to such an extent that the adhesive power of the glue becomes superior to the cohesive power of the glass. Neutral glues should be used for glass and enamels. M.V.K.

Calculating glass resistance to traction. O. KNAPP. *Chim. & ind.*, **24** [3], 528–29 (1930); for abstract see *Ceram. Abs.*, **10** [12], 832 (1931). M.V.K.

Faraday's research on optical glass. ARTHUR MARSHALL. *Jour. Soc. Glass Tech.*, **15** [59], 212–18 (1931).—A report is given covering the six years (1824–30) in which Faraday worked as a member of a sub-committee of the Royal Society appointed to consider improvements in optical glass. Lead borosilicates of many different compositions were made and the physical properties of the glasses are summarized from Faraday's tables. G.R.S.

Note on the transverse strength of glass. C. H. GREENE. *Jour. Amer. Ceram. Soc.*, **15** [1], 59–60 (1932).

Glass diseases and their diagnosis. OTTO STUMM. *Umschau*, **34** [32], 647–49 (1930).—Glass is an "undercooled liquid," *viz.*, a substance which is not permitted to be formed according to its tendency in the melt but which is forced to form glass through a definite course of heating. If the melt is left for a sufficient time at higher temperatures, it changes into a white mass, the devitrification product ("porcelain of Reaumur"). The batch of sand, soda, and lime is fused at certain temperatures at which the smallest particles of the glass must be eliminated in a definite order as "crystals." The crystallization of the glass, called devitrification, is especially harmful when it takes place shortly before the working up. The conditions of melting glass in a tank are such that it is impossible to prevent devitrification under all circumstances and it may appear at any time; it is seen during shaping or in finished objects. It is possible to detect the slightest departure from the proper operating conditions by the study of the characteristic kind of crystal or "crystal type" as it is shown in the devitrification. The devitrifications accumulate at the surfaces of contact of moving layers. They proceed from a

"nucleus" which appears in the center of a spreading spherical crystallization. The crystallization capacity or tendency to devitrification is in close relationship with the viscosity of the glass. Over 1000°, the crystallization capacity has practically no importance, but with decreasing temperature, it always appears stronger when the glass is still thinly liquid. With decreasing temperature, the viscosity of the glass increases and checks the tendency to crystallization; the latter is very slight at 900°. The most important crystal types of a technical lime-soda-silicate devitrification are β-wollastonite, quartz, cristobalite, and wollastonite-cristobalite. Wollastonite is the best-known crystal form; it is a calcium silicate ($CaSiO_3$) and begins to crystallize at about 1100°. Local, sharply limited metals of β-wollastonite crystals present in the glass signify a deficient local homogeneity. Over 1180°, pseudowollastonite is present in a type completely changed. It is seen in slowly cooling melts in the form of snow-white hexagonal plates. The crystal type of quartz is the result of a double conversion of sand grains. It undergoes, at first, a conversion at 575°, followed by bursting into several particles having a cell structure, which are slowly absorbed by the melt. The cell structure is typical for an incomplete fusion of sand grains and shows an insufficient fusing temperature. Cristobalite is the most common crystal form in which silica appears in glass. Its crystals sometimes undergo an unexplained distortion which seems to be due to heterogeneity of the melt. Tridymite consists of small star-like crystals originated from cristobalite. Its presence shows that the glass had an opportunity to crystallize somewhere in the melt. The crystallization of β-wollastonite may cause such a change in the surrounding mass that this "secondary" glass causes another "type," *viz.*, cristobalite, to separate. This explains the frequent appearance of wollastonite and cristobalite. It is an important criterion for the kind and degree of supersaturation of the glass with certain constituents. M.V.K.

Glass devitrification. M. P. VILLARD. *Ind. chim.*, **17** [197], 411 (1930); for abstract see *Ceram. Abs.*, **8** [10], 714 (1929). M.V.K.

Calculating densities of glasses. W. BILTZ AND F. WEIBKE. *Sprechsaal*, **64** [47], 867 (1931).—The calculation of densities of technical glasses according to Winklemann and Schott with the assumption of single oxides does not give satisfactory results. Assuming the existence of definite chemical compounds with the uncombined amorphous silicic acid (quartz glass), good agreements result with the values found. This assumption seems to be authorized by röntgenographic and chemical investigations of glasses. Le Chatelier divided the silicic acid present in glasses into combined and free without knowing the demarcation of both of them. Mathematical valuations of about 400 glasses of different compositions and for glasses of complicated compositions permit the calculation in the manner given. The values used as a basis for calculating the density of compounds represent, in contrast to a former work, not conventional figures, but experimentally ascertained figures. The researches show that the densities of glasses should be calculated from the experimentally ascertained values. They give a new example for the rule of additivity and a proof of the presence of definite compounds in glasses, which compounds result from the phase diagram of crystallized compounds. M.V.K.

Requirements for glasses used in the electric industry. F. SPÄTE. *Sprechsaal*, **64** [47], 867 (1931).—Electrical apparatus and implements using glass are discussed. The requirements and suitableness are given of glasses for incandescent lamps, gas-discharging pipes, special illuminating pipes and glimmer pipes, Röntgen tubes, rectifiers, electron tubes, tubes for wireless telephones, tubes for sound amplifiers, photocells, insulators, X-ray protective glasses, and glasses for condensators. It is shown how the interdependence of the physical and chemical properties of the glasses can be known from their chemical composition and how glasses of a definite composition and having

the desired properties for different uses may be chosen. Data on the world consumption of glasses used in the electric industry are given. M.V.K.

Glasses for use with invisible rays. S. ENGLISH. *Pottery Gaz.*, **56** [654], 1669–70 (1931); see also *Ceram. Abs.*, **10** [9], 630 (1931). E.J.V.

Electrical incandescent lamp. A. L. MARDEN. *Pottery Gaz.*, **56** [654], 1670 (1931).—M. describes the development from the platinum filament lamps, the carbon and osmium filaments, and the drawn-wire filaments of tantalum and tungsten to the modern coiled filament gas-filled lamp. The manufacture of the bulbs and tubing by hand and machine is also described. The special characteristics required in the glass are explained. E.J.V.

Future of glassmelting. EDWARD MEIGH. *Pottery Gaz.*, **56** [654], 1655–58 (1931).—The ideal method of glassmelting is a problem which has not been solved. In regard to this some other problems are (1) reducing cost of raw materials and (2) reducing cost of the melting process which includes consideration of (*a*) furnace design, (*b*) furnace operation, (*c*) refractories, and (*d*) labor. Three methods proposed for electrically melting glass are (1) electric arc, (2) indirect resistance, and (3) direct resistance. Some large scale British experiments now under way are discussed. E.J.V.

Glass manufacturing materials. DOMINION BUREAU OF STATISTICS. *Can. Chem. Met.*, **15** [11], 34 (1931).—Consumption of raw materials for glass manufacture in Canada during 1930 included lead, zinc, and copper, 271,730 lb.; silver nitrate, 2804 lb.; silica sand, 73,349 lb.; soda ash, 27,072 lb.; feldspar, 3925 lb.; fluorspar, 179 lb.; lime, 7858 lb. Sixty-two plants engaged in the manufacture of glass or glass products had a total output valued at $12,191,752. E.J.V.

Glass tile for British tunnel. ANON. *Glass Ind.*, **12** [12], 247 (1931).—The huge tunnel for road traffic underneath the River Mersey between Liverpool and Birkenhead will be lined with glass panels of a dark green shade. The area to be covered is approximately twelve acres and the expenditure on the glass lining will exceed $250,000. E.J.V.

Manufacture of rolled plate. XV. ERNST LUTZ. *Glass Ind.*, **12** [12], 242–45 (1931).—Design and construction of various types of polishing machines are given. A theoretical discussion of the polishing as affected by the eccentricity of the polishing runner is given. Illustrated. For Part XIV see *Ceram. Abs.*, **11** [1], 1 (1932). E.J.V.

Damages from smoke of glass-fusing furnaces. F. FRANCESCHINI. *Ind. Silicati*, **9** [9], 7–10 (1931).—The volatile combustion products from fuels containing sulphur and from the use of raw products containing fluorine or chlorine in the production of glass cause damage to vegetation in the vicinity of the furnace even when the latter has a high chimney. M.V.K.

Developments in American glass manufacture. ALEXANDER SILVERMAN. *Glass Ind.*, **12** [12], 235–41 (1931).—Scientific control of composition and properties is making great strides. New methods for continuous plate and sheet production, electric melting, and annealing are being introduced. The laminated glass industry is making progress in the production of protective glass and articles of artistic merit. The electric bulb industry has developed a new machine and has manufactured glasses of special composition and with an interior etching process. The bottle-glass industry has reached quantity production with the advantage of flexibility of machine use for a variety of articles. New methods of stirring, casting, and annealing of optical glass have been developed. There has also been a large-scale production of inexpensive optical units. Transparent fused quartz is manufactured on a fairly large scale under good control. Refractories have been improved and methods have been found for the prevention of corrosion. Producer-gas units have been improved from the standpoint of economy and cleanliness of fuel. Oil is coming into extensive use and methods for cleansing

and pressure spraying have been devised. Illustrated. See also *Ceram. Abs.*, **10** [10], 690 (1931). E.J.V.

Belgian glass industry. ANON. *Times Eng. Supp.*, **28**, 561 (1931).—Several plate-glass works in Belgium have merged with Libbey-Owens, and in the bottle industry there has been an *entente* of the four largest works. H.H.S.

Glassmaking. EDITORIAL. *Chem. & Ind.*, **50** [46], 923 (1931). G.R.S.

Hand window glass workers tools sent to Chicago museum. ANON. *Amer. Glass Rev.*, **51** [9], 12 (1931).—Tools used by the hand window glass workers have been donated to the Museum of Science and Industry in Chicago by J. M. Siemer, the last president of the National Window Glass Workers. E.P.R.

Science and the glass industry. R. A. GREGORY. *Proc. Soc. Glass Tech.*, **15** [59], 78–81 (1931). G.R.S.

History of the Midland glass industry. I. Early history of glassmaking in Stourbridge district. D. N. SANDILANDS. *Jour. Soc. Glass Tech.*, **15** [59], 219–27 (1931).—Research has proved the existence of an early glasshouse at Eccleshall, started by the families of Tyttery and Tyzack. The necessity of finding new fuel led to experiments in the heating of furnaces by coal. The coal and fireclay deposits no doubt were the reasons for the location of glasshouses at Stourbridge. Because of the local character of the market, the supply outstripped the demand and the glassworkers left Stourbridge in great numbers in early 1700. Experiments were made on colored glass during this period. In 1780 the first leer for annealing was built. See also *Ceram. Abs.*, **10** [3], 182 (1931). G.R.S.

Spon Lane works. D. N. SANDILANDS. *Jour. Soc. Glass Tech.*, **15** [59], 245–51 (1931).—The history of manufacture of sheet, rolled, colored, and optical glass, microscope slides, spectacle glass, dioptric lenses, laboratory and heat-resisting ware, and a variety of other glasses is given. Before 1832 crown was the only kind of window glass made in England. A number of French and Belgian sheet-glass makers were imported. Chance's commenced the manufacture of optical glass after the restrictions were removed in 1845 and continued as the sole maker in England till 1914. A stained-glass department was added in 1846. Rolled plate glass was taken up and large quantities exported. In 1851 the establishment of the lighthouse works was effected which made the firm's name famous. Stained and painted glass departments were added in 1843. G.R.S.

Birmingham's glass industry. D. N. SANDILANDS. *Jour. Soc. Glass Tech.*, **15** [59], 227–31 (1931).—Research shows that a glasshouse was operated in Birmingham in 1762. In 1770 a new method of making an opaque or transparent garnet glass was invented. The earliest application of glass in Birmingham to a definite trade was to the button trade. Canal construction has played an important part in determining the localization of Midland glass works. Master-cutters and toymakers founded the manufacture of glass in Birmingham. G.R.S.

Fifty years of excise duty on glass. D. N. SANDILANDS. *Jour. Soc. Glass Tech.*, **15** [59], 231–45 (1931).—The harmful effects of the high duties on glass at the close of the 18th Century are outlined. In spite of this handicap the Midland glass industry steadily expanded. The production of flint glass increased, and glass cutting was established. The duty on glass was abolished in 1845 and resulted in a decrease in prices, and increased production. A shortage of trained workmen was the cause of the production of much inferior glassware. Exports increased greatly. G.R.S.

Glass-container industry. K. M. HENRY. *Chem. Met. Eng.*, **38** [11], 656 (1931).—The Illinois Pacific Coast Co. plants are equipped to manufacture bottles and jars by the gob-feed process. Improvements in the blowing machines are described. Annealing

by electricity was developed in one of the plants. With the exception of sand, all raw materials used are found on the Pacific coast. G.R.S.

Chemical decoloration. H. LÖFFLER. *Sprechsaal*, **64** [47], 867 (1931).—L. explains the character of physical decoloration to give a better understanding of the difference between physical and chemical decoloration, and the character of a chemical decoloration. The conversion of coloring impurities of the glass into colorless or weak-coloring chemical compositions is discussed. The conversion of ferrous oxide into iron oxide is especially noted. There are four ways to decolorize chemically: (1) ionic exchange as $Ce^{++++} + Fe^{++} = Ce^{+++} + Fe^{+++}$; (2) oversaturation of the glass with oxygen by fusing oxides developing oxygen or salt so that the decomposition of iron oxide into ferrous oxide and oxygen is retarded as with the use of KNO_3; (3) formation of iron oxide into a complex which lowers the partial pressure of oxygen of the iron oxide or "stabilization" of the stage of oxide of the iron as with cerous oxide; (4) making lighter the complex ions of the 3-valent iron as in the action of lanthanum on the color of iron-arsenic complexes. The relation of the physical to the chemical decoloration, the advantages and disadvantages of separate decolorizing methods, and especially the behavior of decolorized glasses with exposure to light are explained from a practical standpoint. M.V.K.

Processes taking place during matting of glass. ELSA HONIGMANN. *Sprechsaal*, **64** [47], 868 (1931).—The mat structure is produced by the protective effect of the reaction products which are formed as crystal nuclei on the glass surface at the beginning of the process of etching and continue to grow during the process. After the end of the process, the protective layer of crystals is removed and a homogeneous rough glass surface remains. The assumption that the protective crystals are hollow is confirmed by microphotos. The behavior of different etchers (sodium fluoride, potassium fluoride, and ammonium fluoride) was investigated and showed that well-scattered mat surfaces cannot be expected when the prevailing reaction product is difficultly soluble, but only when the solubility and the number of nuclei connected with it and the velocity of increase of the reaction products are so large that the nuclei grow independently of the surrounding crystals on the glass surface. The processes taking place during glass etching are discussed from the standpoint of laws of solubility (law of mass action). It is shown by numerous tests that the structure can be changed when the reaction product which is formed during the etching process is added to the matting bath at first. Etching tests systematically made on 3 compound glasses with a constant alkali content and variable content of MgO, CaO, ZnO, BaO, PbO, Al_2O_3, and B_2O_3, and constant content of PbO and BaO, and varied alkali content are described. On the basis of these researches it was possible to prescribe etchings for glasses of any composition. M.V.K.

Silvering and evacuating Pyrex Dewar flasks. R. B. SCOTT, J. W. COOK, AND F. G. BRICKWEDDE. Bur. Stand., *Jour. Research*, **7** [5], 935–43 (1931).—A method of silvering and evacuating Pyrex Dewar flasks is described. The insulating properties of silvered flasks prepared in this way are such that even in the wide-mouth cylindrical flasks filled with liquid air near to the lip there is no boiling, the change of the liquid air to the gaseous phase taking place entirely by surface evaporation. R.A.H.

Work of Faraday on colloidal gold and ruby glass. ROBERT ROBERTSON. *Chem. Trade Jour.*, **89** [2314], 292 (1931).—The colors of ruby glass of which gold is a constituent and of ruby, blue, and yellow liquids in which gold solutions had been reduced by reagents were studied by Faraday. The Royal Institution has bottles containing these ruby liquids and films on glass from their evaporation that were used in his research. The behavior of these colored liquids, when examined by reflected and transmitted light and when subjected to attack by chemical reagents and to the process of filtration, led Faraday to the conclusion that they were not solutions of gold, but con-

tained in suspension gold particles in minute size. This deduction is entirely confirmed by X-rays which show that the particles are of metallic gold. Similarly, he concluded that ruby glass owed its color to solid particles of gold diffused throughout the glass. The smallness of these particles is estimated as 1 volume of gold in 750,600 volumes of his ruby fluid, a value in agreement with the values of size of particles determined later by the ultramicroscope. The subject of the protection of these finely divided particles against their effort to coagulate to larger ones has played an important part in colloid chemistry. Here again Faraday found that the ruby color is stabilized by the addition of a jelly, and much later Zsigmondy, by observing the time elapsing before colored gold sols coagulated when substances like gelatin, gums, and silicic acid were added, assessed the capacities of these additions in respect to this protective action. See also *Ceram. Abs.*, **9** [2], 104 (1930). M.V.K.

Dissolution of gold in glasses and the red coloration of glass by gold. R. Long. *Chim. & ind.*, **26** [4], 795–96 (1931).—L. discusses the theories of Zsigmondy and Siedentopf on the action of gold on glass coloration and describes the researches of B. Lange on ruby and sapphire glasses (see *Ceram. Abs.*, **10** [9], 704–705 (1931)). The conclusions of Lange concerning the annealing of glass containing gold are confirmed by the researches of L. made on a mirror glass of 7 mm. thickness of which the optical density for different radiations of the visible spectrum was measured with a spectrophotometer. It was found that (1) the density increases with time with the same annealing temperature. The more rapidly it increases, the shorter the wave-length is for the yellow, orange, and red parts of the spectrum (wave-length superior to 5800Å). After a certain time (variable according to the temperature), the densities for the red, blue, and violet are practically constant, while densities of the yellow and orange continue to grow. (2) With the same time of annealing, the density increases considerably with the temperature, the more rapidly, the shorter the wave-length for those superior to 5800Å; the less rapidly, the shorter the wave-length for those inferior to 5800Å. Or, a high annealing temperature rapidly produces dark glasses of a purple color which becomes violet the longer the annealing time when observed in daylight by transmission. With moderate annealing temperatures and after a longer time (several hours), glasses of a red tone are obtained which absorb relatively little. M.V.K.

Surface alterations and efflorescences on glass. I. F. H. Zschacke. *Glashütte*, **60** [21], 367–72 (1930); *Chim. & ind.*, **24** [3], 629 (1930).—The following deteriorations are caused by a series of physico-chemical phenomena which depend on different causes and appear on the surface of the glass: (1) formation of surface deposits and other deeper alterations due to the surrounding humidity; (2) surface deposits and deteriorations caused by reheating and remelting the glass; (3) loss of a part of the transparency caused by reheating over a blast burner; and (4) surface devitrification produced by humidity and temperatures more or less high. Z. carefully studied these alterations, their origin, the cause and the mechanism of their formations, and the different influences exerted, *i.e.*, temperature, pressure, time, humidity, etc. Glass is considered impermeable to gases at ordinary temperatures and pressure. It is no longer impermeable, however, when the temperature and pressure vary. Chemical changes (hydraulitic reaction and hydration of alkalis) produce physical changes on the glass surface. Z. gives means of avoiding surface alterations in the glass exposed to the action of humidity and means of removing noxious influences. M.V.K.

Black glass. S. Rolf. *Céram. Verrerie*, pp. 387–89 (1931); for abstract see *Ceram. Abs.*, **10** [9], 633 (1931). (*C.A.*)

Using organic matter as colorant in a glass melt. M. F. Shur and A. W. Utkin. *Glashütte*, **60** [17], 279 (1930); *Chim. & ind.*, **24** [2], 359 (1930).—Manganese peroxide is used for coloring glass orange, but it is expensive and cannot be used for cheap glass.

Another method of obtaining orange color is by using sifted horse manure dried at 70°. For 120 kg. of the batch, 1 to 3 kg. of manure are sufficient for glasses having a fusing point at about 1400° (lime–sand–soda–potassium–sulphate). For glasses having a fusing point at about 1470° (sand–feldspar–chalk–boric acid–soda–potassium), up to 9 kg. manure should be used as the latter is partly burned up. It is sometimes possible to use 2 coloring agents simultaneously, *e.g.*, manure and manganese oxide. It is, however, a delicate operation because the oxide is often reduced by the carbon from the manure and the color changes to green. M.V.K.

Coloring of glasses by carbon, sulphur, and mercury. L. SPRINGER. *Sprechsaal*, **64** [44], 810–13 (1931).—In a former paper, S. showed that substances containing carbon may cause a yellow color of a glass even without the presence of sulphur compounds. New experiments were carried on using a glass containing 100 parts sand, 20 parts calcium carbonate, and 40 parts soda, to which were added sugar, charcoal from sugar, glycerol coal, and graphite, respectively. Besides these glasses, melts were made with additions of sulphur, cadmium sulphide, potassium, ferrous sulphide, and sulphur and carbon together. The melts were made in a small furnace and fired with oil gas. Only in a few cases, using chemically pure substances with addition of glycerol coal in a platinum crucible, the glasses showed no yellow color. All other experiments with carbon additions, however, resulted in yellow glasses. If the yellow color is not caused by the carbon alone, two possibilities occur: (1) Very small amounts of oxides from iron, titanium, and vanadium contained in the refractory material of the crucible may explain the yellow color together with the carbon. These oxides alone, however, will not give the yellow color. (2) Small amounts of sulphur, sulphates, etc., may be contained in the carbon which is introduced into the glass or in the combustion products. The final conclusion is that a large amount of carbon and only a very small amount of sulphur are necessary to cause the yellow color of the glass. Iron sulphide alone will give a greenish color caused by the iron, as iron sulphide is decomposed quickly in the glass. If, however, carbon is present at the same time, iron sulphide will give a yellow color. Pure graphite added in a small quantity (1 part to 100 parts of sand) gives no coloring of the glass. If more than 2 parts are added, the graphite is found in the glass in a dispersed form without causing an appreciable coloring. Commercial graphite, however, gives, in small quantities, a yellow to dark-brownish color, no graphite remaining unchanged in the glass. If more than 4 parts of commercial graphite are added, a large amount of graphite remains unchanged in the glass, but the glass is not colored. This behavior of graphite cannot be explained yet. Some experiments were carried out with additions of mercury compounds and other substances. It was found that the mercury compounds alone will not color the glass; if iron or aluminum is present at the same time, coloring will occur. Results by Zschacke, who found a coloring effect of mercury, are explained by the presence of iron or aluminum in his melts (see *Ceram. Abs.*, **10** [7], 488 (1931)). W.M.C.

Modern artistic glasses. W. E. S. TURNER. *Pottery Gaz.*, **56** [654], 1667–69 (1931).—T. briefly discusses the earliest glasses and the discovery of so-called English lead-crystal glass in 1750. Differences between English and Continental glasses are pointed out. The blowpipe lifted the art of glassmaking from an art craft to quantity production. Glass cutting, engraving, present-day artistic glass, purer glass now made, colored glass, artistic molded glass, and threaded and iridescent glasses are discussed. E.J.V.

Shatterproof glass. E. DIETEL. *Metallbörse*, **21**, 1323–24, 1371–72 (1931).—A historical résumé is given of the development of safety glass. (*C.A.*)

Glass universal. WILLIAM P. HELM AND NORMAN EVANS. *World Today*, pp. 423–32 (Oct., 1931); for abstract see *Ceram. Abs.*, **10** [7], 494 (1931). (*D.I.*)

Proposals for standard tests on ampoule glass. Report of Sub-Committee on Ampoule Glass. ANON. *Proc. Soc. Glass Tech.*, **15** [59], 59–70 (1931).—The purpose of the test is to enable those ampoules which yield little alkali to be distinguished from those which yield much, so that the latter can be rejected as containers for medicinal solutions in question. Various tests now in use are described and discussed. Tests carried out on both whole ampoules and on the crushed glass are described. Tests recommended cover those to be applied (1) to glass when crushed and (2) to whole ampoules. An acid solution of methyl red is the test solution used. The crushed glass is heated in a flask with the test solution. The test solution is placed in the whole ampoules which are sealed and heated in steam at a pressure of 15 lb. per sq. in. for half an hour. See also *Ceram. Abs.*, **10** [6], 417; [12], 833 (1931). G.R.S.

Recent developments in optical glass. W. M. HAMPTON AND W. N. WHEAT. *Pottery Gaz.*, **56** [654], 1669 (1931).—Dense barium flint series have unusual optical properties. The utilization of improved pots and methods of founding has made possible the production of heavy flints of refractive index 1:8 in large quantities and in large blocks. E.J.V.

Sheet and plate glass. R. F. TAYLOR. *Pottery Gaz.*, **56** [654], 1670 (1931).—After an explanation of the requirements of a sheet of glass and the problems involved in producing a sheet, T. gives the history of the development of sheet glass starting with the hand-blown process and continuing through the cylinder-drawn process, the Fourcault process, the Libbey-Owens process, and finally, the latest process developed at the Pittsburgh Plate Glass Co.'s works. In the case of plate glass, the old pot method, the Bicheroux process, and the flow process of the Ford Motor Co. are discussed. The continuous grinding and polishing process, the manufacture of wire glass, and the latest development, toughened glass, are also described. E.J.V.

"Glass snow." ANON. *Amer. Glass Rev.*, **51** [10], 18 (1931).—"Glass snow" is made by spraying molten glass under high pressure through very small holes into a vacuum chamber. As the particles come through the nozzle they explode and fall into a cooling liquid where they solidify. These particles, about the size of snowflakes, each with several sharp cutting edges to penetrate the skin and flesh, are then dipped into deadly poison or bacteria. Dropped over a city from airplanes, a blizzard of "glass snow" would not only annihilate most of the population in a few hours, but would also make the city uninhabitable for months as the flakes would continue to be blown about by each fresh gust of wind. There is no known defense against their deadly effect. E.P.R.

Ultra-violet radiation flat-glass specifications of Federal Board. ANON. *Nat. Glass Budget*, **47** [31], 3 (1931); *Amer. Glass Rev.*, **51** [9], 25–31 (1931).—The Federal Specifications Board issued a proposed federal specification for glazing glass for transmitting ultra-violet radiations of certain wave-lengths. E.P.R.

Automatic devices in annealing and firing tanks. F. H. ZSCHACKE. *Werksleiter*, **5** [15–16], 317–22 (1931); *Feuerfest*, **7** [10], 156 (1931).—The development of annealing and firing tanks in the glass industry is discussed and a series of the latest devices used in them are described. M.V.K.

BOOKS

Colloid Chemistry of Glass. (Kolloidchemie des Glases.) R. E. LIESEGANG. Theodor Steinkopff, Dresden, and Müller & Schmidt, Coburg, 1931. 48 pp. 4.00 Rm. Reviewed in *Quim. Ind.*, **8** [93], 265–66 (1931); *Amer. Glass Rev.*, **51** [8], 21 (1931).—The different colloidal aspects of glass and its manufacture and decoration are presented under the following headings: (1) the glass state, (2) size of particles of the raw materials and in the melt, (3) cooling and hardening, (4) devitrification, (5) opal and milky glass,

(6) mat etching and polishing, (7) breaking and cutting glass, (8) coloring of glasses, (9) viscosity, and (10) gases and water in glass. M.V.K.

Permeability of glass to ultra-violet radiations. P. GILARD, P. SWINGS, AND A. HAUTOT. Hayez, Bruxelles, 1931. Reviewed in *Chim. & ind.*, **26** [4], 1006 (1931); see also *Ceram. Abs.*, **10** [12], 831 (1931). M.V.K.

PATENTS

Electric leer. VERGIL MULHOLLAND. U. S. 1,833,090, Nov. 24, 1931. Apparatus for annealing glassware comprising a tunnel having a metallic floor formed with a plurality of angularly disposed heat-reflecting surfaces, an endless conveyer having its ware-bearing strand supported throughout its width directly by the floor for transporting articles of glassware through the tunnel, and a plurality of electric heating elements associated with the floor and adapted to heat the conveyer by heat transmitted thereto from the floor by radiation and conduction.

Making sheet glass. WILLIAM L. MONRO, JR. U. S. 1,833,119, Nov. 24, 1931. Apparatus including a chamber having a plurality of bays formed in the chamber wall and adapted to receive glass from the chamber, and a single Fourcault sheet-drawing unit associated with each bay, the bays being arranged in pairs with an open space on each side of a pair of bays at least as long as a debiteuse for a unit.

Handling sheet glass. LAMBERT VON REIS. U.S. 1,833,239, Nov. 24, 1931. The method which comprises forming glass into a ribbon, delivering such ribbon on a roller bed, severing the ribbon as received on the roller bed into sheets of desired lengths, accelerating the speed of the rollers on which the severed sheet is resting at the time of severing, feeding the severed sheet off the rollers at accelerated speed, and successively reducing the speed of such rollers as the tail of the severed sheet moves from thereover.

Handling sheet glass. LAMBERT VON REIS. U. S. 1,833,240, Nov. 24, 1931. A device for forming glass sheets and delivering them to a leer comprising, in combination, a mechanism for forming a glass ribbon, a roller bed for receiving this ribbon extending from the forming mechanism to and through the leer, a cutter on the roller bed in advance of the forming mechanism for severing the ribbon into sheets of desired length, a roller section for variable speeds in advance of the cutter, a drive for rotating the rollers of this section at the speed of sheet formation, another drive for rotating these rollers at a speed higher than that of sheet formation, means for reducing the individual rollers of this section from the high speed to the speed of sheet formation as soon as the tail of a sheet traveling on the section passes from over the individual rollers, a second section of rollers in advance of the first one consisting of two sets of alternating rollers, one set of which is adapted to be driven at the high speed of the rollers of the first section and the other set at leering speed, means for allowing the rollers of one of the two sets to run idle when the other is being positively driven, and a third section of rollers in advance of the second one, all rollers of which are designed to be driven at leering speed for the purpose specified.

Plate-glass rolling machine. RICHARD GENENGER. U. S. 1,833,248, Nov. 24, 1931. A machine comprising a pair of spaced segment-shaped standards, pendulum rollers for rockingly supporting these standards, a pair of coöperative plate-forming rolls mounted in the standards, a receiver for the liquid glass mass carried by the standards on the front side of the forming rolls, a delivery chute for the rolled plates so carried by the standards on the rear side of the forming rolls that it assumes at the beginning of the rolling operation a substantially horizontal or slightly rising position in the direction of the delivery of the plates, and means for rocking the standards on the pendulum rollers to tilt the receiver, the forming rolls, and the chute in unison to various positions.

Temperature control of glassworking or transporting rolls. JEAN MEYER. U. S.

1,833,297, Nov. 24, 1931. The method which comprises creating a nonrotating surface within the roll eccentric thereto and cooler than the interior surface of the roll, and cooling such inner surface of the roll by radiation therefrom to the stationary cooled surface.

Continuous two-table bottle machine. KARL E. PEILER. U. S. 1,833,302, Nov. 24, 1931. A glassware-fabricating machine comprising a blank-mold table, a blank mold thereon, a neck mold associated with the blank mold, means for constantly supporting the molds in a position to be closed in axial alignment with each other, a blow-mold table, a blow mold thereon, means for continuously rotating the tables, the rotation of the tables causing the blank and neck molds and the blow mold simultaneously to approach each other while traveling in the same general direction through a transfer zone, means operating in synchronism with the rotation of the mold tables for opening the blank mold during the movement thereof toward the transfer zone to leave a previously formed parison suspended from the neck mold, means for opening the blow mold and means actuated in timed relation with the arrival of the molds at the transfer zone for imparting a lateral component of motion to the open blow mold toward the suspended parison, the last-named means being constructed to cause the blow mold to follow the path of movement of the parison about the axis of the blank-mold table, means for closing the blow mold about the parison during the movement thereof about the axis of the blank-mold table, and means for opening the neck mold to release the parison in the blow mold, whereby the parison is transferred to the blow mold while the molds are rotating.

Drawing glass. ARTHUR E. SPINASSE. U. S. 1,833,379 to 1,833,382, Nov. 24, 1931. (1) In apparatus for drawing sheet glass from an open bath at a particular level, a hot adherent edging device having upwardly-extending spaced-apart walls to form a passage therebetween open at top, bottom, and one side with the side opening wider at all portions than the finished thickness of the sheet, the member being located wholly spaced from and fixed above the surface of the bath for adherently embracing and shaping the border portion only of the meniscus of the forming sheet, the device being of such form so as to shield the forming border portion of the sheet which passes between and above the walls from the bath beneath the device, and means for modifying and controlling the temperature of the glass below the edging device. (2) In apparatus for drawing sheet glass from the free surface of a bath of molten glass at a particular level, edging devices for preventing the narrowing tendency of the sheet comprising a pair of horizontal plates each having spaced-apart walls upwardly extending above the bath to form a slot adapted to embrace the initially drawn border portions of the sheet, the walls forming the slot being adapted to adherently engage the side faces of the rising border portions to shape the portions and prevent narrowing of the sheet, the horizontal plates extending from and lying remote on each side of the slot in contact with the bath to shield the rising border portions above the slots from the molten bath below, and means for modifying and controlling the temperature of the glass adjacent the slots in the devices. (3) In apparatus for drawing sheet glass from an open bath of molten glass, hot-slotted means with V-shaped slots therein fixedly supported and spaced above the surface of the bath to adherently embrace the rising border portions of the sheet being drawn from the open bath of molten glass. (4) In a sheet-glass drawing apparatus, the combination with a tank for containing a bath of molten glass at a particular level, anchorage means in the walls of the tank, an edging device comprising a hot plate having an open V-shaped slot therein for receiving the border portion of the meniscus being drawn, from which the sheet forms, the walls which form the slot being adapted to contact with and adhere to the side faces of the rising border portion of the meniscus to prevent the narrowing of the sheet, the plate being of such form as to protect the forming border portion of the

sheet from the bath below, means for holding the plates fixed in contact with the surface of the bath adjacent the anchorage means, and means for drawing the border portions of the meniscus in shaping contact through the slotted plates and the remaining portion of the sheet from the free surface of the bath.

Making plate glass. HALBERT K. HITCHCOCK. U. S. 1,833,398, Nov. 24, 1931. Apparatus for making a glass sheet comprising a casting table fixed in inclined position and having a flat, plain surface for receiving the glass, a roll mounted for movement along the table from its lower to its upper end and adapted to roll out into a sheet a body of molten glass teemed across the lower end of the table, a runway extending laterally from the lower end of the table and adapted to receive the sheet as it slides off the table, and means for rolling the sheet to substantially uniform thickness as it passes over the runway.

Glass-feeding apparatus. WILLIAM T. BARKER, JR. U. S. 1,833,479, Nov. 24, 1931. In glass-working apparatus, a container for molten glass having an outlet for the delivery of glass in a downwardly flowing stream, a movable support adapted to contact with the lower end of the stream, cam-actuated means for causing a predetermined downward movement of the support while in supporting contact with the stream to shape the stream as desired, means for severing the stream from the oncoming glass when the stream has attained the desired length and shape, and fluid pressure operated means for returning the support upward into supporting contact with the new stream.

Sprinkler bottle. PHILIP G. LLOYD. U. S. 1,833,971, Dec. 1, 1931. A device having a neck portion with an opening extending therethrough, the outer portion of the opening being of less diameter than the inner portion, there being an abrupt interior annular shoulder between the portions of the opening constituting liquid restraining means.

Molding glass containers. ROBERT PATTERSON. U. S. 1,833,973, Dec. 1, 1931. The method of producing an angular glass container which includes the step of forming a rounded blank with ribs extending lengthwise of the blank in the same plane with the longest diameter of the blank, thereby to insure uniform chilling of the blank at opposite sides of the ribs, and thereafter blowing the blank in an angular cavity divided diagonally of the cavity and blank, thereby to produce straight corner ribs on the finished container and to flatten the blank ribs against opposed walls of the cavity to obliterate the ribs without lateral distortion.

Cutting sheet glass. ROBERT P. CALLARD AND JOHN H. MOLLER. U. S. 1,834,120, Dec. 1, 1931. In a method for the manufacture of sheet glass, the steps consisting in passing the sheet through an annealing leer, scoring the sheet as it issues from the leer along two parallel lines adjacent each longitudinal edge thereof, and in then breaking the sheet first along the outer score line and subsequently along the inner score line.

Glass-cutting apparatus. ROBERT P. CALLARD AND JOHN H. MOLLER. U. S. 1,834,143, Dec. 1, 1931. In combination with means for receiving and supporting a moving sheet of glass as it issues from an annealing leer, means associated with the receiving and supporting means for trimming the longitudinal edges from the sheet including a cross member extending transversely thereof, a pair of spaced cutters carried by the cross member adjacent each longitudinal edge of the sheet, and separate means associated with the cutters independently operable to move the cutters transversely with respect to the sheet to vary the distance therebetween.

Glassware-forming machine. ALBERT N. CRAMER. U. S. 1,834,384, Dec. 1, 1931. A glassware-forming machine comprising an annular series of ware-forming units each including a gravity fed blank mold, a finish mold, a turnover unit adapted to transfer blanks to the finish mold, means to blow the blank to final form in the finish mold, and means in part carried by the turnover unit to apply air internally of the blown blank in the finish mold after the blow to final form.

Forming glassware. LEONARD D. SOUBIER. U. S. 1,834,433, Dec. 1, 1931. The combination of a mold carriage rotatable about a vertical axis, molds thereon, a continuously rotating horizontal drive shaft, a cam drum thereon comprising a cam track extending circumferentially and longitudinally of the drum, rolls carried by the mold carriage positioned and arranged to engage the track and cause the carriage to be rotated step-by-step, a transfer arm, means on the arm for receiving a charge of glass, means for actuating the arm in synchronism with the step movements of the mold carriage and thereby moving the charge-receiving means back and forth between a charge-receiving position and a delivery station, means to transfer the charges of glass to the molds at the delivery station, the means for actuating the transfer arm comprising a rock shaft on which the arm is mounted, a pinion on the rock shaft, a rack for operating the pinion, and a cam on the drive shaft connected to reciprocate the rack.

Working molten glass. LEONARD D. SOUBIER. U. S. 1,834,478, Dec. 1, 1931. The combination with a container for molten glass of means providing a gathering chamber positioned in its entirety over a gathering area of the glass in the container, and means for rotating the chamber comprising an upright wall about a vertical axis extending therethrough, the chamber having a side opening therein periodically brought into position to permit the introduction of a gathering implement.

Making glass. VERGIL MULHOLLAND. U. S. 1,834,631, Dec. 1, 1931. In apparatus for the production of glass from glass batch, a melting compartment having a floor, means for supplying batch upwardly through the floor to the melting compartment to form piles on the floor thereof, means for supplying heat to the upper surfaces of the piles to melt the batch, and means for directing the glass so made to a refining chamber.

Manufacture of sheet glass. ARTHUR E. SPINASSE. U. S. 1,834,656, Dec. 1, 1931. The method of producing sheet glass which consists in drawing the sheet upwardly from an open bath of molten glass, adherently dragging the thickly drawn border portions of the forming sheet, at points wholly spaced above the surface of the bath, through and against hot anchoring elements to maintain the desired width of the sheet, confining the rising border portions of the sheet within suitable surrounding elements and exposing the confined border portions in predetermined degrees to a cooling effect of the external atmosphere while at the same time applying heat under the bath beneath the forming border portions of the sheet to thereby regulate the temperature and adherent dragging action of the forming glass passing through the anchoring and surrounding elements.

Forming sheet glass. JOHN L. DRAKE. U. S. 1,834,942, Dec. 8, 1931. In apparatus for forming sheet glass, movable means for receiving a downwardly flowing body of molten glass and for treating opposite surfaces thereof in the same manner, and means for subsequently reducing the body of glass to sheet form.

Glass-fabricating machine. WILLIAM J. MILLER. U. S. 1,835,172, Dec. 8, 1931. (1) In a glass-fabricating machine, the combination with a rotary mold support provided with a plurality of radially disposed arms, of a plurality of unitary fabricating mechanisms carried by the arms, the units comprising a frame composed of an upper and a lower frame member which are connected together, a parison mold mounted on the upper frame member, a finishing mold mounted on the lower frame member, a transfer device working between the molds, means for closing the upper end of the parison mold, means for fabricating the parison from below in the parison mold, and means for blowing the parison in final form in the finishing mold, all of the means being operated by the rotary movement of the mold support. (2) The combination of a movable support, a parison mold carried by the support, the upper end of the mold being open to receive the charge of molten glass and the parison being fabricated therein from below, a closure adapted to be brought into engagement with the upper end of the mold for the fabricating operation, a carrier for the closure, a shaft mounted for rotary movement upon

which the carrier is mounted, means whereby the shaft is rotated by the movement of the support, a second shaft mounted for longitudinal movement and operatively connected to the carrier, and means whereby the second shaft is moved by the movement of the support. (3) The combination of a movable mold support, a parison mold carried by the support and open at its upper end for the reception of the mold charge of molten glass, a neck ring positioned beneath the mold, a plunger operated by the movement of the mold support and coacting with the neck ring to form the neck of the parison, means controlled by the movement of the support for blowing the parison in the mold, and means whereby when the plunger abnormally resists movement it is disconnected from its operating means. (4) The combination of a support provided with a seat, a partible parison mold carried by the support, the mold being open at the top to receive the mold charge of molten glass and the parison being fabricated therein from below, a movable neck ring occupying the seat below the mold, a vertically movable plunger adapted to coact with the neck ring, and means for discharging compressed air into the seat to clear it of obstruction.

Glassware forming machine. LEONARD D. SOUBIER. U. S. 1,835,351, Dec. 8, 1931. In a machine for forming glassware, a frame, a blank-mold unit slidable vertically on the frame, the unit including a blank mold, neck mold, and gathering head, means normally yieldingly holding the elements of the unit in their uppermost position, a plunger and blow head reciprocable into and out of coöperative engagement with the elements, and means operable at intervals to cause such downward movement of the plunger and blow head that the blank mold is moved downwardly to a charge-gathering position.

Spraying glass, etc. JOHN HENRY JUERS. U. S. 1,835,402, Dec. 8, 1931. In a spray apparatus, the combination of a support for the material to be sprayed, a spray gun movable in a transverse and longitudinal direction, means to reciprocate the spray gun transversely, a track toward which the spray gun is pressed yieldingly, and means to change the angular position of the track at each reciprocation of the spray gun.

Glass-feeding apparatus. WILLIAM T. BARKER, JR. U. S. 1,835,553, Dec. 8 1931. In glass-feeding apparatus having a container provided with a discharge outlet, an implement reciprocable in the glass toward and from the outlet for controlling the flow of glass through the outlet, an oscillatory lever adjacent to the container, motion-transmitting connections between the lever and the implement whereby the oscillations of the lever will cause reciprocations of the implement, a cam adjacent to the lever, a motion-transmitting member actuated periodically by the cam and adjustably connected with the lever to oscillate the lever, a second cam adjacent to the lever, and means actuated by the second cam to shift the connection between the lever and the lever-oscillating member longitudinally of the lever so as to vary in a cyclic order the extent of different oscillations of the lever, whereby the amplitude of different reciprocations of the implement will be varied in a corresponding order and mold charge masses of different sizes will be delivered in a cyclic order through the outlet.

Handling glassware. DANIEL B. WESTIN. U. S. 1,835,579, Dec. 8, 1931. Apparatus for handling ware comprising a pair of arms disposed in laterally spaced relation and pivotally supported at their inner ends, a second pair of arms pivotally supported between the outer ends of the first arms, a ware-supporting device pivotally connected to the outer ends of the second arms, means for moving the first arms about their pivots, means for simultaneously moving the second arms about their pivots, and means for effecting pivotal movement of the ware-supporting device in predetermined relation to pivotal movement of its supporting arms, the apparatus being arranged to effect oscillatory movement of the ware-supporting device between ware-receiving and ware-delivering stations located in a substantially common plane.

Floating bridge wall. SAMUEL B. BOWMAN. U. S. 1,835,690, Dec. 8, 1931. A bridge wall for glass tanks including a series of floating blocks arranged in abutting but disconnected relation, the lower portions of the blocks being saddle-shaped, aligned pipes extending inwardly from opposite sides of the tank, the blocks adapted to straddle the pipes, a water inlet pipe projecting into each of the first-mentioned pipes, an overflow pipe leading from the upper side of each of the first-mentioned pipes, and a valve in each of the overflow pipes and inlet pipes.

Backing-off mechanism for grinding machines. ERNEST A. WALKER AND HARVEY A. ALLISON. U. S. 1,835,733, Dec. 8, 1931. In a grinding machine, means to support and rotate a piece of work, a grinding wheel, the work and wheel being mounted for relative axial movement, means to rotate the wheel, and means effective to alternately positively advance and positively withdraw the wheel toward and from the work in timed relation to the rotation of the work, the means including a rock shaft, an arm on the shaft, a continuously rotating eccentric circular disk, a link pivoted on the eccentric disk and pivotally connected to the arm, and a sliding support for the grinding wheel and a second arm on the rock shaft connected to the support.

Making glassware. ROBERT W. CANFIELD. U. S. 1,835,758, Dec. 8, 1931. A suction-gathering head comprising a supporting frame having an opening therein, a pressing plunger slidably mounted in the opening and having a glass-receiving cavity therein to provide the upper portion of a gathering receptacle, a member pivoted to the frame for completing the gathering receptacle, means for moving the plunger into coöperative pressing relation with a mold, and connections between the plunger and the member for moving the latter out of receptacle-completing position during the movement of the former into pressing position.

Distributing glassware. JOHN E. SCHRODER. U. S. 1,835,814, Dec. 8, 1931. An automatic stacker for glassware comprising a plurality of deflectors, each deflector being movable into a deflecting position and a nondeflecting position, means associated with each deflector for moving it from deflecting to nondeflecting position by the passage of the glassware diverted by the deflector in its deflecting position, and means associated with each deflector and operable by the passage of the ware through the deflected path controlled by the preceding deflector for moving it into its deflecting position.

Leer for annealing glassware. JOHN N. WILSON. U. S. 1,836,054, Dec. 15, 1931. In a leer for annealing glassware, a tunnel having hollow, liquid-cooled side, top, and bottom walls, comprising upon opposite sides of the tunnel a series of hollow metallic chambers, each chamber having a vertical side-wall section and inwardly projecting bottom and top sections, means for maintaining a current of liquid through the chambers having an inlet at the bottom and an outlet at the top of each chamber, a pipe connecting the outlet of one chamber to the inlet of the next succeeding chamber, and a vent in the connecting pipe.

Sheet-glass forming machine. CLYDE W. BELDEN. U. S. 1,836,356, Dec. 15, 1931. In a wire-glass forming machine, a furnace including a substantially closed working chamber containing a mass of molten glass and comprising a bottom, side walls, and top, the top and bottom having openings therein in substantial vertical alignment with one another, means for passing a wire mesh through the working chamber and also through the openings so that some of the glass will adhere to the wire to form a sheet of wire glass, and means positioned within the working chamber above the mass of molten glass for protecting the wire mesh.

Drawing sheet glass. JAMES C. BLAIR. U. S. 1,836,358, Dec. 15, 1931. Apparatus for making sheet glass comprising a tank furnace in which molten glass is produced, there being an elongated opening in the lower portion of the refining end of the tank, a slab therebeneath having a recess therein, the walls of the sides of the opening project-

ing downwardly into the recess whereby molten glass flows through the opening and is guided to the bottom of the recess, thence up around the downwardly projecting walls, and over and down the sides of the slab, and means for drawing away these converging flows in sheet form.

Glass buck. JOSEPH P. CROWLEY. U. S. 1,836,362, Dec. 15, 1931. A glass buck comprising a frame for supporting sheets of glass and including end members, members arranged transversely of the buck and extending past the end members, and means arranged longitudinally of the buck and engageable with the transverse members for preventing accidental displacement of the sheets of glass being supported.

Sheet-glass apparatus. JOHN L. DRAKE. U. S. 1,836,363, Dec. 15, 1931. In sheet-glass apparatus, the combination with means for carrying a relatively newly formed sheet of glass in a definite predetermined path, of means for cutting the sheet longitudinally along its border portions while in a semiplastic condition, and stationary means disposed in the path of travel of the sheet for removing the border portions before they have become set.

Sheet-glass grinding and polishing apparatus. JOHN L. DRAKE AND FRANK FRASER. U. S. 1,836,364, Dec. 15, 1931. In apparatus for surfacing sheet glass, a plurality of pairs of abrasive rolls arranged in two lines for receiving the glass sheets to be surfaced therebetween, feed rolls positioned between adjacent pairs of abrasive rolls, means for driving the feed rolls to feed the glass between the abrasive rolls, means for driving the abrasive rolls, means for reciprocating the abrasive rolls transversely of the line of feed of the glass, and means carried at the ends of the feed rolls and engaging the edges of the glass for preventing transverse movement of the glass upon reciprocation of the abrasive rolls.

Sheet-glass cutting apparatus. JOHN L. DRAKE. U. S. 1,836,365, Dec. 15, 1931. In glass-cutting apparatus, means for supporting a glass sheet to be cut, a plurality of cutters associated with the supporting means and beneath which the sheet is adapted to be passed, and means engageable by the sheet as it is passed beneath the cutters for effecting movement of the cutters into and out of cutting engagement with the sheet.

Sheet-glass apparatus. LUKE C. MAMBOURG. U. S. 1,836,378, Dec. 15, 1931. In sheet-glass apparatus, a receptacle containing a mass of molten glass and provided with a cap, a deputer arranged within the mass of molten glass, vertical curtain walls depending from the cap and located at opposite sides of the deputer, substantially horizontal lip tile extending between the curtain walls and deputer with the inner adjacent ends of the lip tile resting upon the latter, the cap, curtain walls, and lip tile coöperating to form a substantially closed drawing chamber, and heating means located beneath the lip tile at opposite sides of the deputer.

Rotary cut-off mechanism. ARCHIE W. PLATT. U. S. 1,836,390, Dec. 15, 1931. A cutting device comprising a rotatable member, a knife guided for movement radially with respect to the member, a series of speed-increasing levers carried by the member and connected to the knife for controlling the movement thereof, means for rotating the member, and means operable through the levers to project the knife by a comparatively quick movement away from the axis of the member as the knife approaches the lower part of its orbit.

Sheet-glass cutting apparatus. JOSEPH A. REECE. U. S. 1,836,393, Dec. 15, 1931. In sheet-glass cutting apparatus, means for supporting and carrying the sheet in a definite predetermined path, vertically aligned cutters positioned above and beneath the sheet adjacent each edge for simultaneously scoring opposite surfaces of the sheet, and means for subsequently cracking off the cut edge portions.

Producing sheet glass. JOSEPH A. REECE. U. S. 1,836,394, Dec. 15, 1931. The process of producing sheet glass consisting in completely melting and refining molten

glass in a series of separate containers while maintained in a substantially quiescent state, flowing the molten glass intermittently from the several containers centrally into the recessed top of a substantially vertically positioned slab, dividing this downflow of glass at the bottom of the recess into two equal upflows, each of which spills over and flows down one of the opposite converging sides of the slab, and then continuously drawing away these two meeting flows in single sheet form.

Sheet-glass apparatus. WILLIBALD TRINKS AND JOHN D. KELLER. U. S. 1,836,409 to 1,836,411, Dec. 15, 1931. (1) In sheet-glass apparatus, the combination with means for forming a sheet from a mass of molten glass, of metallic means arranged at one side of and in close proximity to the sheet for preventing convection currents in the air and gases surrounding the sheet from contacting therewith, and means for protecting the first-named means from variable air currents. (2) The combination with means for forming a sheet from a mass of molten glass, of a shield arranged at one side of the sheet for protecting the sheet, the shield consisting of a metallic plate, the lower portion thereof being shaped to fit substantially in the curvature of the sheet meniscus, a second plate carried by the back of the first plate but spaced therefrom to define a duct extending transversely of the sheet and through which is adapted to be circulated a temperature-control medium, and a backing of insulation for the second-named plate. (3) The combination of means for drawing a sheet upwardly from a mass of molten glass, width-maintaining devices arranged to engage opposite sides of the sheet at both edges thereof adjacent the sheet source, and a shield arranged at one side of the sheet for protecting it.

Regenerator. WILLIBALD TRINKS. U. S. 1,836,412, Dec. 15, 1931. A regenerator comprising a regenerative chamber having an inlet at one end, checkerwork arranged within the chamber and spaced from the bottom thereof to provide a passage therebeneath, and baffle means positioned within the passage beneath the checkerwork and in line with the inlet.

Sheet-glass apparatus. WILLIBALD TRINKS AND JOHN D. KELLER. U. S. 1,836,413, Dec. 15, 1931. In sheet-glass apparatus, the combination with means for drawing a sheet vertically from a mass of molten glass, of a pair of shields arranged at opposite sides of the sheet, a substantially vertically disposed member at each end of the shields for supporting the corresponding ends thereof, a pivotally mounted lever to which each supporting member is pivoted, means for rocking the levers to raise and lower the shields vertically as a unit, means carried by the members and engaging the levers for swinging the members about their pivots to move the shields as a unit to vary the angle thereof with respect to the sheet, and means carried by the supporting members for moving the shields bodily as a unit toward and away from the sheet.

Making plate glass. WILLIAM OWEN. U. S. 1,836,493 and 1,836,494, Dec. 15, 1931. (1) Apparatus for making a sheet of glass comprising a leer having continuously operating forwarding means, a runway at the entrance end of the leer also having forwarding means operating continuously and in the same direction as the leer-forwarding means, and a car mounted for movement back and forth along the runway. (2) Apparatus for making a sheet of glass comprising a leer having continuously operating forwarding means.

Plate-glass surfacing block. ROBERT A. MILLER. U. S. 1,836,542, Dec. 15, 1931. In combination, a surfacing block, a universal joint support for the block permitting it to tilt and rotate and located above the center of gravity of the block, and counterbalancing means mounted for circular movement about the center of support of the block and adapted to be moved outward by centrifugal force when the support is moved in a circular path about a center of rotation.

Glass-forming machine. WALTER M. CRILE. U. S. 1,836,646, Dec. 15, 1931. A

glass-forming machine including a continuously revolving table, a carriage mounted on the table to move radially thereof, and a vertical turret mounted on the carriage.

Splice-laminating glass. LOUIS BARTELSTONE. U. S. 1,836,785, Dec. 15, 1931. A device for abutting sheets of nonbrittle material and holding them in contact during a splice-laminating operation.

Nonshatter glass. HENRY A. GARDNER. U. S. 1,836,914, Dec. 15, 1931. A composite body comprising a plurality of glass sheets firmly united together by means of a nonbrittle composition containing chlorinated diphenyl alkyd resin.

Glass-blowing machine. RICHARD LA FRANCE. U. S. 1,837,164, Dec. 15, 1931. (1) In a glass-forming machine, the combination of a mold carriage and molds thereon, means to rotate the carriage continuously about a vertical axis, a frame mounted to oscillate about the axis, a blowing head carried by the frame, a piston motor operable to move the head into and out of engagement with the molds, and automatic means comprising a continuously rotating cam to oscillate the frame. (2) In a glass-forming machine, the combination of a rotating carriage, an inverted parison mold open at its upper end to receive a mold charge, a neck mold, an inverting head carrying the neck mold, means to blow a charge of glass to hollow form in the parison mold, means to blow a cooling blast against the upper end of the hollow parison, means to open the parison mold leaving the parison extending upwardly from the neck mold, means to rotate the inverting head and carry the parison downward, and a finishing mold to receive the parison.

Making rolled glass strip. PILKINGTON BROS., LTD., AND E. B. LE MARE. Brit. 360,021, Nov. 11, 1931.

Safety glass. R. DELLOYE. Brit. 360,292, Nov. 11, 1931.

Pressing glassware. MACBETH-EVANS GLASS CO. Brit. 360,318, Nov. 11, 1931.

Troughs for feeding molten glass to molds charged by suction. C. H. RANKIN AND RANKIN AUTOMATIC GLASS FEEDER CO., LTD. Brit. 360,442, Nov. 18, 1931.

Annealing leers. BRITISH HARTFORD-FAIRMONT SYNDICATE, LTD., AND T. WARDLEY. Brit. 360,447, Nov. 18, 1931.

Manufacture of wire glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Brit. 360,361, Nov. 18, 1931.

Wall of glass building blocks, tile, etc. NAAMLOOZE VENNOOTSCHAP GLASFABRIEK LEERDAM VOORHEEN JEEKEL, MIJNSSEN, & CO. Brit. 360,625, Nov. 18, 1931.

Leers for annealing glassware. BRITISH HARTFORD-FAIRMONT SYNDICATE, LTD., AND T. WARDLEY. Brit. 360,825, Nov. 25, 1931.

Manufacture of lenses, etc. E. GOWLLAND. Brit. 361,055, Nov. 25, 1931.

Manufacture of spun glass. F. POLLAK. Brit. 361,220, Nov. 25, 1931.

Manufacture of compound glass. SOC. DES USINES CHIMIQUES RHÔNE-POULENC. Brit. 361,254, Nov. 25, 1931.

Tempering glass by jets of air directed at right-angles to the surface. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Brit. 361,277 and 361,278, Nov. 25, 1931.

Wire netting for wire glass. L. ROWLAND. Brit. 361,749, Dec. 2, 1931.

Glass for absorbing ultra-violet and infra-red rays. DEUTSCHE SPIEGELGLAS A.-G. Brit. 328,520, Aug. 2, 1929. Oxides of Co and Fe are added to a batch for producing glass which is substantially colorless and the batch is melted under reducing conditions. The Co and Fe oxides may be less than 0.3% each of the finished glass and ferrosoferric oxide is preferably used. Absorption of heat rays is increased by addition also of As or Sb oxide, each less than 0.5%. C or Sn chloride may be used as a reducing agent. See following abstract. (*C.A.*)

Glass of high transparency to ultra-violet rays. DEUTSCHE SPIEGELGLAS A.-G.

Ger. 524,374, May 10, 1927. Reducing agents capable of deoxidizing the gases retained in the melt are added to the melt. Suitable agents are powdered metals forming colorless oxides, and organic compounds rich in N. Thus, in preparing glass containing SiO_2 72, CaO 12, alkali 16, and Fe_2O_3 0.03 parts, there may be added to the melt powdered Al 750 or urea 700 g. for each 100 kg. of SiO_2. See also *Ceram. Abs.*, **10** [12], 840 (1931). (*C.A.*)

Glass. PATENT-TREUHAND-GES. FÜR ELEK. GLÜHLAMPEN M.B.H. Ger. 531,108, March 1, 1930. A mixture of the customary initial materials is compressed to a coherent mass, sintered, kneaded while still in a thermoplastic state, and then reheated near to or at the fusion point. Materials evolving gases when heated should not be included in the initial mixture. Kneading may be effected by passing the masses through porcelain rollers. (*C.A.*)

Apparatus for homogenizing molten glass. MONTAN- UND INDUSTRIALWERKE VORM. JOHN D. STARCK. Austrian 123,972, March 15, 1931. (*C.A.*)

Structural Clay Products

Salt glazing a clay of low vitrifying temperature. H. F. DINGLEDINE. *Jour. Amer. Ceram. Soc.*, **15** [1], 82–83 (1932).

Firing structural tile. T. W. SHOOK AND G. R. SYLVESTER. *Jour. Amer. Ceram. Soc.*, **15** [1], 78–81 (1932).

Air leakage through various forms of building construction. F. C. HOUGHTEN, C. GUTBERLET, AND C. A. HERBERT. *Heating, Piping, Air Conditioning*, **2** [12], 1044–48 (1930).—The authors' report on a continuation of a study (see *B.S.A.*, No. 795 (1929)) of air infiltration through various types of wall construction. Each test panel was built up as a partition between a chamber within which air pressures representing various wind velocities ranging from 5 to 30 m.p.h. could be produced and a second collecting chamber in which the amount of air passing through the panel was measured. A table and graph show the air infiltration through the panels in cu. ft. per hour per sq. ft. wall surface for wind velocities of 5, 10, 15, 20, 25, and 30 m.p.h. The panels included (1) a 13-in. plastered brick wall, (2) the same after removal of the plaster and repainting, (3) the same after (*a*) one, (*b*) three, and (*c*) six coats of paint, (4) a frame wall of siding, paper, sheathing, studs, lath, and lime plaster, (5) the same type with gypsum plaster, (6) as for (5) but sized and papered, (7) a stucco panel of sheathing, studding, paper, metal lath, and stucco, and (8) a 13-in. brick and hollow-clay block panel. Measurement was also made of the air leakage through cracks between plaster and frame in the frame wall panels. The following are the infiltration values in cu. ft. per hour per sq. ft. wall surface for each type with wind velocities of 5 and 30 m.p.h., respectively: Type (1) 0.006; 0.121. Type (2) 1.35; 20.00. Type (3*a*) 1.25; 15.65. Type (3*b*) 1.05; 12.50. Type (3*c*) 0.02; 0.25. Type (4) 0.25; 4.10. Type (5) 0.25; 1.35. Type (6) 0.10; 0.95. Type (7) 0.12; 0.90. Type (8) 1.05; 16.15. The average values obtained for air leakage through cracks between frame and plaster or stucco were 0.06 at 5 m.p.h. and 0.65 at 30 m.p.h. The ages of the panels tested ranged from 183 to 406 days. (*B.S.A.*)

Contributions to the study of florescence. Staining of face brick. F. L. BRADY AND B. BUTTERWORTH. *Brit. Clayworker*, **40** [474], 263–65 (1931).—Conclusions obtained are as follows: (1) To obtain good purple sand-faced brick, clay rich in iron and reducing conditions during firing should be used. The yellow-brown staining which causes most trouble is due to the clay, not to the sand. (2) Choice of sand for facing is quite open. Staining is a result of sulphate florescence and hence reduction in total

sulphates present in the brick should produce improvement. Reduction in the sulphur content of the coal breeze used in the brick deserves attention. (3) Increase in time or temperature of soaking will favor the elimination of sulphates. (4) Under certain conditions the ferrous compounds which produce staining may be oxidized inside the brick and so rendered harmless. Brick should be protected from large amounts of rain water when stacked in yards for storage. R.A.H.

Water penetration through brick-mortar assemblages. L. A. PALMER. *Jour. Clay Prod. Inst. Amer.*, **1** [1], 19–30 (1931); *Rock Prod.*, **34** [24], 34–38 (1931).—From a study of the rates of water penetration through the separate materials, brick and mortar, and through assemblages of these materials, the data indicate that when continuity of material is broken, the rate is markedly decreased. The speed of wetting is greatly reduced by intervening mortar joints. This is true with both lean and rich mortars. These data were obtained with extremely fast-absorbing types of brick. It is believed, therefore, that the times recorded for wetting through the assemblages are minimum values that would be obtained were the study extended to include a wide variety of clay and shale brick. It is improbable that water will be transmitted through solid 8-inch walls of brick if there are no open spaces between mortar and brick and if some provision is made in so designing the wall that the header brick do not connect directly with the interior. This may be done by furring the inner wall or by the use of metal ties in place of headers. E.C.C.

Analysis of properties desired in masonry cements. F. O. ANDEREGG. *Rock Prod.*, **34** [25], 40–42 (1931).—The investigation of leaky brick walls led to a study of masonry mortars under practical conditions. An analysis of the properties for masonry cements indicates the importance of workability, adhesion to masonry units, compressive strength, weather resistance, water-tightness, volume change, flexibility, efflorescence, fading, and staining. These properties are discussed. See also *Ceram. Abs.*, **11** [1], 31 (1932). W.W.M.

Protection of green brick against frost by salt. SLOBODIANIK. *Tonind.-Ztg.*, **55** [92], 1274–75 (1931).—The addition of sodium chloride to the water used in preparing the body will prevent the freezing of the green brick when being dried in open sheds. The color of the fired brick will be only slightly changed by such an addition. W.M.C.

Sealed joint in brick wall construction. SEALED JOINT CONSTRUCTION CORP. *Clay-Worker*, **96** [5], 285–86 (1931).—The sealed-joint process consists of ordinary brick in which there is a V-shaped groove in the top, bottom, and each end set with an L-shaped piece of special alloy metal hooked into each brick. This strip is longer than the brick and the L-shaped hook is longer than the brick is thick. Consequently, lengthwise this strip hooks into the two brick abutting it on either end and also ties into the groove of the brick immediately above it. When the wall is completed the metal strip inserts form a mesh reinforcement vertically and horizontally and the wall is water-tight. Illustrated. E.J.V.

New wall-bearing ceramic tile. P. J. CONLEY. *Clay-Worker*, **96** [5], 291 (1931).—An enameled or salt-glazed brick, $3^7/_8$ x $3^7/_8$ x 8 in. in size and with the surface divided into two squares, represents wall-tile faces. Illustrated. For patent see *Ceram. Abs.*, **10** [12], 849 (1931). E.J.V.

Use of clay products in sound insulation. V. L. CHRISLER. *Jour. Clay Prod. Inst. Amer.*, **1** [1], 30–38 (1931).—The building industry is in need of some form of construction with good sound-insulating qualities. At the Bureau of Standards, investigations of the sound-insulating qualities of materials varying from wrapping paper to an 8-inch brick wall and with a range in weight per square foot between the two extremes of 1 to 10,000 showed that there is a straight-line increase in the sound-reduction factor measured in decimals as the logarithm of the weight per square foot of the

material is increased. These data agree with those of other investigators. The greatest possibilities in the construction of soundproof walls lie in building hollow walls which have as little connection between faces as possible and are designed to reduce the energy of vibration passing through the wall. The transmission of sound by impact does not obey the laws of air-borne sound. In tests made with an impact machine it was found that a wooden structure does not transmit impact noises as readily as masonry and that a masonry slab is almost a perfect transmitter of impact noises. To secure any degree of insulation against impact noises the floors should be built in layers. E.C.C.

Brick fillers and bedding courses for street pavements. JOHN S. CRANDELL. *Jour. Clay Prod. Inst. Amer.*, **1** [1], 39–52 (1931).—C. describes experiences with different types of beddings and fillers. A successful bedding material for brick and block paving is a mixture of 93% sand with 7% tar applied on a concrete base. E.C.C.

Research and modern tendencies in the structural clayware industry. C. H. J. V. PHILLIPS. *Brit. Clayworker*, **40** [474], 265–69 (1931).—Scientific study of building materials has pushed back the boundaries set up by natural limitations of raw materials and possibilities of color, texture, strength, etc., have been widely increased. Color depends on (1) presence of compounds of metals having tinctorial value, (2) proportion of various compounds present, (3) their chemical mode, (4) hardness of firing, (5) fineness and degree of clay mixing, and (6) kiln atmosphere. P. states that the tendency is toward larger units especially where the brick are covered by ashlars or other units. The importance of internal texture or structure is discussed as well as the modern methods of obtaining strength with lightness and the results obtained from a control of porosity of structural materials. The endurance of fired clayware in regard to both physical and chemical stability is also discussed in detail. R.A.H.

Green-colored brick. ANON. *Tonind.-Ztg.*, **55** [87], 1210 (1931); for abstract see A. McK. GREAVES-WALKER. *Ceram. Abs.*, **10** [9], 640 (1931). W.M.C.

Stabilization of retail price of brick. FRANKLIN DICKEY. *Clay-Worker*, **96** [5], 277–79 (1931).—In a clear and concise discussion D. points out reasons for the face-brick manufacturer to stabilize the retail price of brick. GEORGE A. BASS. *Ibid.*, **96** [5], 279–80 (1931).—B. points out some simple primary principles of policy. E.J.V.

Marketing face brick. TYLER STEWART ROGERS. *Clay-Worker*, **96** [5], 272–75 (1931); for abstract see *Ceram. Abs.*, **11** [1], 65 (1932). E.J.V.

Application of hollow tile. E. BANGERT. *Tonind.-Ztg.*, **55** [91], 1262–63 (1931).—The possibilities of the use of hollow tile in building constructions are discussed. W.M.C.

New gray glazed brick. JOHN WHITTACRE. *Clay-Worker*, **96** [5], 292 (1931).—A new gray glazed brick suitable for exterior and interior building has been developed by the Whittacre-Greer Fireproofing Co. E.J.V.

Earl Carroll Theater. ANON. *Arch. Forum*, **55** [5], Part I, 563–71 (1931).—The exterior walls are of brick in ivory, buff, and black. E.P.R.

Brick buildings in Tangermuende. ANON. *Tonind.-Ztg.*, **55** [90], 1251–52 (1931).—Some interesting ancient brick buildings at Tangermuende, Germany, are described. Illustrated. W.M.C.

BOOK

Brick engineering. II. L. B. LENT. *Arch. Forum*, **55** [2], Part I, 16 (1931).—This is the second in a series of three volumes, issued by the Common Brick Mfrs. Assn., of handbook size which are planned to cover the design and construction of all forms of brick masonry. Volume I deals with the physical and chemical properties of brick and brickwork and the significance of those properties in the performance of brick

masonry. This volume covers the design and construction of brick masonry in buildings. E.P.R.

PATENTS

Sewer tile. JOHN VOYTKO. U. S. 1,833,098, Nov. 24, 1931. A tile for the construction of tubes or conduits for sewers, etc., consisting of a sector of fired clay formed at the sides with dove-tailed tongues and grooves, the intermediate tongues at one side being in staggered relation to the tongues at the other side and of greater length and width than the grooves, whereby interfitting tongues and grooves are spaced apart on all sides for the reception of cement fillings, the outermost tongue being formed and adapted to abutt against the bottom of the coinciding groove, the intermediate interfitting grooves and tongues being recessed at opposite points to form channels for the reception of cement filling.

Bricklaying machine. JAMES WILLIAM KAVANAGH. U. S. 1,833,582, Nov. 24, 1931. An apparatus for use in bricklaying comprising a movably supported container provided with a hopper portion to receive the bricklaying composition including a sloping wall, side walls, and an end wall, the lower portions of the walls constituting a neck for the hopper portion, a door hinged to the front wall and having its lower edge spaced slightly above the bottom edges of the neck of the hopper, a rod operably connected to the inner face of the door for adjusting the door to open and close the neck, and a hook on the upper edge of the rod adapted for engagement with the upper edge of the sloping wall for holding the door in closed position, substantially as and for the purposes set forth.

Masonry wall and damp-proof insert therefor. EMILE WEIL. U. S. 1,833,925, Dec. 1, 1931. In a plastic joint for masonry, etc., the combination with adjacent brick or blocks and the interposed plastic binder, of a protective insert imbedded in the binder and providing a plurality of flexible, yielding projections at each face of the binder for contact with the adjoining faces of the brick or blocks at a plurality of points to form a plural sealing contact against the passage of moisture.

Sewer pipe. CLARE H. CURRIE. U. S. 1,834,603, Dec. 1, 1931. A sewer pipe comprising an outer cylindric shell of relatively thick concrete, a thin layer of a noncorrosive sealing compound covering the inner surface of the shell, an inner lining consisting of thin plates of a vitreous substance joined edge to edge, and anchor members consisting of pins of noncorrosive material passing through holes in the plates with their shank portions imbedded radially in the outer shell.

Conduit. ROY A. SHIPLEY. U. S. 1,835,245, Dec. 8, 1931. A junction section for multiduct conduits consisting of a plurality of separately formed duct sections fired together.

Floor construction. KARL E. WAGNER. U. S. 1,836,347, Dec. 15, 1931. A floor comprising a major grid of horizontal beams and a plurality of composite arch panels carried thereby, each panel comprising a rectangular group of substantially cubical hollow tile in planar arrangement between the beams and abutting mutually at their bases, the upper edges of the tile being indented on two sides to provide a network of channels, and a minor grid of concrete bars molded into and filling the channels.

Refractories

Progress in refractory materials. J. H. CHESTERS. *Refrac. Jour.*, **7** [11], 483–85 (1931).—A refractory material is defined as a material "difficult to fuse." In a liquid all the particles are free to move and the material assumes the shape of the container. In a solid the particles still move unless the material is cooled to the absolute zero of

temperature (−273 °C), but they vibrate about a mean position. As energy is added, the amplitude of vibration of the particles increases; the temperature of the body is rising. If the temperature continues to rise, a point will be reached at which the displacement of a particle is such that it no longer tends to return to its original position. This particle has "melted." With pure materials the melting point is quite sharp, although the fact that materials have an appreciable vapor pressure below their melting point shows that certain particles have already begun to roam. With impure materials and supercooled liquids, *e.g.*, silica glass, melting occurs over a range. Thus, Braunbek calculates the melting points of the alkali halides. The relation between melting point and crystal structure, obtained by Braunbek, is very simple. If T is the absolute melting point and d the lattice distance, *i.e.*, the length of the unit cube in the crystal, then $dT = K$ (where K is a constant). This equation was calculated for a face-centered cubic crystal and a different constant is required for body-centered crystals. If, however, d is expressed in terms of atomic weights and density, the constant is the same for body-centered and face-centered cubic crystals. The equation has been found to give fair agreement for the magnesia series. The calculation of the melting points of more complex materials, *e.g.*, spinel, would be more difficult, but it is possible that empirical formulas may be devised which could be used in theoretical investigations on possible refractories. Born calculated the compressibility, X, of the alkali halides in terms of the lattice distance, d, and a combination of his formula with that obtained by Braunbek for melting point yields the result $-X^{1/4}\ T$ (or XT^4) = constant. This equation is the mathematical expression of the relation between refractory materials and abrasives and explains why most abrasives, *e.g.*, silicon carbide, corundum, sandstone, etc., are also used as refractory materials. It is interesting to note that the diamond is both the most refractory and the most incompressible substance known. The cone test does not give the melting point of the material, but the temperature at which it deforms under a light load, *i.e.*, the weight of the cone tip. Exactly how much the melting point determined differs from that of the grog itself will depend on the rate of heating, *i.e.*, the cone size. A material of high "cone-melting point" may have a comparatively low abrasion resistance at temperatures well below the melting point and this explains the disappointing results obtained with certain materials of high "melting point" and good (chemical) resistance to slag attack when exposed to a swirling charge. With some refractory materials, *e.g.*, silica brick, intercrystallization occurs and the hot strength is no longer dependent on the softening range of the bond. In magnesite and chrome, intercrystallization is difficult to produce and the hot strength of the material is controlled by the softening range of a relatively nonrefractory bond. A material may have a high refractoriness under load and yet fail due to attack by corrosive slags. Sillimanite is an excellent refractory, but wears away very rapidly in the presence of ferruginous slags. Many methods have been devised to test slag resistance. In general, one of the following methods is used: (1) The slag is heated in a small crucible made from the material to be tested and the amount of wear and slag entry is determined. (2) A bar of the material is suspended in molten slag and the rate of solution is observed. (3) The cone-melting points of mixtures of slag and refractory material are determined. (4) The material is heated with a gas flame, the slag being introduced into the flame in the form of a fine powder. The amount of wear and slag entry is determined. Salmang has made use of method (1) to study the slag resistance of a number of materials, in particular "chamotte." By finding the amount of wear caused by various pure oxides and mixtures of oxides, he obtains empirical formulas which express the wear as a function of the chemical composition of the slag. An extension of this work to the variation in slag attack with the chemical composition of the refractory material would yield the basis of a quantitative theory of slag attack.

It is hoped that the application of this test will yield valuable information about slag attack and will lead to the development of materials of high slag resistance for use in industrial furnaces. Theoretical considerations and experimental work both point to the desirability of using purer materials to obtain high slag resistance, while the work on erosion shows the need for materials of high abrasion resistance produced by intercrystallization either of a single material, as in the case of a silica brick, or by reaction between two or more materials giving a compound. See also *Ceram. Abs.*, **10** [6], 435 (1931). E.P.R.

Researches on the specific resistance of some highly refractory oxides at high temperatures with special consideration for their use in electric kilns. G. SIMON. *Sprechsaal*, **64** [45], 834 (1931).—The specific resistance of ZrO_2, MgO, Al_2O_3, $ZrSiO_4$, and of some mixtures of ZrO_2 and MgO was determined up to about 1500°. It may be assumed from the course of the resistance curves that the stable monoclinic form of ZrO_2 has a greater resistance than the metastable tetragonal modification and that the formation of a volume- and temperature-stable cubic modification depends on other circumstances than on the presence of at least 1.4% MgO and of a temperature of 1700° alone. The conversion of monoclinic into tetragonal zircon dioxide for manufacturing crucibles is possible from the electrical standpoint. It has not been possible, however, to prepare a volume- and temperature-stable material with ZrO as a ground mass. M.V.K.

Ultra-red radiation of refractory materials. BERTHOLD WREDE. *Mitt. Kaiser-Wilhelm Inst. Eisenforsch. Düsseldorf*, **13** [9], 131–42 (1931); *Giesserei*, **18** [33], 662–63 (1931).—The significance of the radiation properties of refractories for the steep in Siemens-Martin kilns is discussed. The ultra-red heat radiation of different refractory materials and grog brick were investigated with a prismatic spectrometer; the radiation samples were heated by an illuminating gas-air blast. The comparison with the heat spectrum of the black bodies of the same temperature shows the absorptive power of the materials investigated in dependence on the wave-length. Further, the absorptive power of the material investigated is given for black total radiation at the investigation temperature. This absorptive power results from the proportion of the area of the spectrum of the materials investigated to the area of the spectrum of the black bodies having the same temperature. M.V.K.

High-temperature tensile tests on refractories. J. H. CHESTERS AND W. J. REES. *Refrac. Jour.*, **7** [11], 475–79 (1931).—An apparatus is described whereby refractory materials may be heated to 1500°C in a molybdenum wire-wound furnace under a tensile load of 8 or 15 lb. per sq. in. and their breaking temperatures determined. The materials tested include magnesite (electrically fused Grecian and Austrian), magnesite cement, mixtures of magnesite and chrome, magnesite and zircon, zircon and ball clay, and certain cupola-lining materials. The results on magnesite show that the commercial materials tested had a breaking temperature between 1400°C and 1500°C under a load of 15 lb. per sq. in. This temperature indicates the softening temperature of the natural bond. A 50-50 mixture of magnesite and chrome was found to have a breaking temperature higher than either magnesite or chrome. Where intercrystallization occurs, *e.g.*, in a silica brick, the breaking temperature is nearer the fusion point of the brick than in the case of materials whose bonding depends on a less refractory cement. See also *Ceram. Abs.*, **10** [12], 843 (1931). E.P.R.

Specific heat of magnesium and aluminum oxides at high temperatures. GORDON B. WILKES. *Jour. Amer. Ceram. Soc.*, **15** [1], 72–77 (1932).

Reversible heat expansion of refractory brick. ANTON KANZ. *Feuerfest*, **7** [10], 155 (1931); for abstract see *Ceram. Abs.*, **10** [12], 843 (1931). M.V.K.

Apparatus for testing resistance to pressure of refractories at high temperatures. G. CHAUDRON, M. GARVIN, AND A. VILLACHON. *Chim. & ind.*, **21**, 2 (1930); *Feuerfest*,

7 [10], 148 (1931).—A kiln for testing resistance to pressure of refractory materials at temperatures over 1600°C is described. The lower part is made of graphite and the upper part of iron. A measuring instrument of high sensitiveness shows the beginning of the decrease in resistance while an optical pyrometer (Ribaud) shows the temperature. Magnesite materials prefired to 2000° with 1.6% silicic acid and more showed a decrease in resistance; pure magnesite showed only a viscous deformation. Other oxide additions such as alumina, chromium oxide, and iron-lime oxide seem to have no effect on the mechanical properties of magnesium oxide. Fe_2CaO_3 seems to affect viscosity slightly. M.V.K.

Modern viewpoints on heat-resistant brick and its applications. GUNNAR HULT. *Tekniska Foreningens i Finland Fördhaudlingar*, **51**, 45–53, 79–85, 117–20 (1931).—The important characteristics to be considered in heat-resistant brick are the melting point or softening point, resistance to attack by the material treated, low coefficient of expansion, ability to stand temperature changes, and permanency of shape on drying after erection of furnace. The discussion is illustrated with examples from Finnish practice. (*C.A.*)

Refractories: Birmingham Metallurgical Society Discussion. C. E. MOORE, *et al. Jour. Bham. Met. Soc.*, **11** [4], 409–29 (1931).—M., opening the discussion, grouped the facts under the headings heat, load, spalling, abrasion, and corrosion. W. F. Brazener dealt with refractories in the copper industry. (*B.N.F.M.R.A.*)

Andalusite as a refractory. F. H. RIDDLE. *Jour. Amer. Electrochem. Soc.*, pp. 225–40 (1931); abstracted in *Refrac. Jour.*, **7** [11], 508 (1931); see also *Ceram. Abs.*, **11** [1], 38 (1932). E.P.R.

Mellon Research Institute. ANON. *Refrac. Jour.*, **7** [11], 488 (1931).—The Heat Insulation Fellowship has produced alumina monohydrate from bauxite for use in electric and gas furnaces, which gives an extended temperature range with higher insulating values than other refractories. It can be molded into large blocks, thus eliminating joints in the furnace. E.P.R.

Iron compounds as mineralizers in the conversion of kaolinite into mullite and quartz into tridymite. P. P. BUDNIKOFF AND W. G. POPOFF. *Feuerfest*, **7** [10], 145–46 (1931).—The authors discuss several cases of the formation of mullite in grog blocks and tridymite in quartz blocks in the presence of iron compounds. In the latter case, the iron compounds proved to be excellent mineralizers, producing complete conversion. The "black Dinas" obtained in such a manner shows a high mechanical strength and a considerably better chemical resistance in the arches of a Martin kiln. M.V.K.

Estimation of the alumina content of diaspore and burley clay from the silica content. M. E. HOLMES AND W. D. KELLER. *Jour. Amer. Ceram. Soc.*, **15** [1], 68–71 (1932).

Silicates with high alumina content. V. ŠKOLA. *Chem. Listy*, pp. 30–34, 59–61 (1930).—S. gives a survey of literature relating to production of mullite ware, beginning with the citation of the study of Bowen and Greig (see *Jour. Amer. Ceram. Soc.*, **7**, 234–54 (1924)). He mentions especially the opinion of W. Eitel and his collaborators that mullite is a fine mixture of corundum and silicium oxide (*Keram. Rund.*, 599, 633 (1926)) and that a similar process takes place as in the case of the cementite in cast iron. The production of various mullite stones, especially of "Uramidon," a product of the Chemical Union Ústi, Bohemia, and the masses Alurit and Elektron, products of the Western Bohemia Kaolin and Chamotte Works and Slovakian Magnesite Works, Ltd., in Czechoslovakia are also discussed. R.B.

New process for the utilization of Korean alunite. HIROMU TANAKA. *Proc. World Eng. Cong.* [Tokyo, 1929], **31**, 289–90 (1931).—Alunite ($K_2Al_6(OH)_{12}(SO_4)_4$), calcined at 600°, liberates H_2O. It is then readily attacked by acids or alkalis. Adding NH_4OH gives Al_2O_3, $(NH_4)_2SO_4$ and K_2SO_4. By crystallization, yields of 97 and 86% of

K_2SO_4 and $(NH_4)_2SO_4$, respectively, were obtained. The insoluble residue (Al_2O_3, SiO_2, and Fe_2O_3) + 20 to 40 times its weight of H_2O, is treated with SO_2 for 3 to 5 hr. at 60 to 70°. About 90% of the Al_2O_3 is dissolved as Al sulphite and removed by filtration. Heating at 100° liberates the SO_2, precipitating Al as a basic sulphite, which is calcined at 900° to give Al_2O_3. (*C.A.*)

French bauxite. ANON. *Metal Ind.* [London], **39** [6], 136 (1931).—Bauxite is used in the production of aluminum, "ciment fondu" or cast cement, refractory materials, abrasives, and chemicals. The bauxite deposits of the world are given. French bauxite deposits amount to 60,000,000 metric tons. The bauxite is divided into three classes: (1) normal, with 55 to 60% alumina, total impurities not exceeding 20%, (2) white or siliceous bauxite with up to 55% alumina (silica varies from 5 to 20%), and (3) red bauxite containing up to 52% alumina and 25% impurities. Its production is centralized by four major companies. M.V.K.

Bauxite deposits in the Urals. ANON. *Econ. Rev. Soviet Union*, **6** [22], 526 (1931).—Rich bauxite deposits have been discovered in the Alapayevsk district of the Urals. They contain up to 56% clays and are located at a depth of 15 to 35 m. M.V.K.

Chrome brick. ANON. *Brit. Clayworker*, **40** [474], 246–47 (1931).—Chrome brick probably have fluctuated in popularity more than any other refractory. Cost, inability to resist load at working temperatures, variation in quality of the raw ore from different localities, etc., are reasons. The most valuable deposits are in Greece. The raw ore must be carefully sorted prior to exportation. The concentrate is ground to a fixed fineness and mixed with the bond. The bond may be clay, fire clay, bauxite, magnesia, water, a mixture of calcium and aluminum sulphates, or some combination of any of the materials. The ore should contain not less than 6% silica. The physical conduct of the chrome brick and brick prepared from other refractory materials and coated with chromite are discussed. A table of typical compositions of chrome ore is included and the use of either the ore or brick in such typical applications as nickel and nickel-copper blast furnaces, smelting of antimony, lead, bismuth, and steel, buffer linings for furnaces, gas-fired furnaces, tap holes, spouts, etc., is described. R.A.H.

Geology of Macedonian chromite deposits. G. HIESSLEITNER. *Berg- Hüttenm. Jahrb.*, **79** [2], 47–57 (1931); *Feuerfest*, **7** [10], 155 (1931).—G. discusses the characteristics of geological structure of some chromite iron regions in Macedonia, the shape and structural appearance of the ore materials, and the process of formation of the bodies. M.V.K.

Electrothermal enrichment of graphite. J. S. TARASSOV AND V. J. TROUBITZYNE. *Zhur. Prikladnoĭ Khim.*, **4** [1], 35–50 (1931); *Chim. & ind.*, **26** [4], 878 (1931).—There are three methods for enriching graphite, (1) chemical, (2) mechanical (flotation), and (3) electrothermal. The chemical purification produces a pure graphite but is complicated and expensive; the mechanical method produces graphite of low qualities. The authors used the electrothermal method the principal features of which are as follows: (1) Natural graphite is heated to over 1500° or 1600°. (2) The impurities, such as metallic oxides, silicic acid, sulphide compounds, etc., are reduced by carbon. (3) Oxygen (as CO) and sulphur as well as silicon are eliminated from the reaction zone and form with the carbon carburetted compounds which dissociate into metal and amorphous graphite at 2000°. At 2500 to 3000°, the metals, silicon, and other impurities are completely eliminated as vapors. The granulometric composition of graphite changes after refining, the fine fractions decreasing due to the volatilization of the elements of the ashes. The graphite crystals disaggregate under the action of the temperature and become very thin. With this method, graphites containing 0.01% ashes were obtained. M.V.K.

Preparation and uses of graphite. EUGEN RISHKEVICH. *Farben Chem.*, **2**, 354–58

(1931).—The mining, refining, and uses of graphite are reviewed. As a result of improved refining processes the uses of graphite are increasing constantly. Illustrated. (*C.A.*)

Manufacture of crucibles. ANON. *Metal Ind.* [London], **39** [2], 27 (1931).—The Battersea Works of the Morgan Crucible Co., London, is described. The manufacture of graphite and fireclay crucibles, retorts, muffles, furnaces, combustion tubes, thermocouple tubes for laboratories, stoppers, nozzles, and sleeve brick is described. M.V.K.

Researches on refractory magnesite materials. LONGCHAMBON AND KO-FUH-TSIANG. *Rev. mét.*, **28** [6], 324–29 (1931); *Feuerfest*, **7** [10], 150–51 (1931).—Magnesite is found in nature as magnesium carbonate mostly in serpentine rocks. The largest deposits are found in Austria, Greece, Hungary, Russia, Sweden, and the U.S. Greek magnesite is the purest with 94 to 99% $MgCO_3$ content. Magnesite is fired to sintering at 1500 to 1600° in shaft or rotary kilns heated by gas and then crushed. Caustic magnesia is used as binding agent. The blocks are pressed in hydraulic presses and dried. Magnesite blocks are fired with silica materials to 1600°. The authors investigated (1) the sintering firing of magnesite at temperatures at which magnesite reaches its highest density, (2) agglomeration of sintered magnesite, (3) influence of natural and artificially added impurities on refractoriness of magnesite, and (4) influence of firing. The raw materials used and the method of manufacture of the samples are given. Chemically separated magnesium hydrate gives up its chemically combined water at 600° and converts into MgO with a density of 2.9. This density changes on heating and is represented in a table. The different admixtures and their influence on the refractoriness of magnesite are as follows: (1) Alumina lowers the refractoriness of magnesium mixtures. (2) Iron oxide is an excellent binding agent but when used in larger quantities lowers the softening point rapidly. (3) Lime injures the cohesion of the blocks and cannot be used. (4) Silica produces a solid lime binding but affects the softening point. A simultaneous addition of silicic acid and lime or iron oxide is more injurious. (5) A mixture of lime and iron oxide is an excellent binding agent. The softening point of such blocks is over 2000°. Pure magnesia blocks should be prefired to 2000° to give satisfactory results. Commercial magnesite blocks were tested also. It was found that their cohesive power is low at high temperatures and with a charge of 2 kg./sq. cm., they begin to soften at 1400°. The thermal expansion tests showed that the expansion is uniform although relatively high up to 1000°. It is affected by firing and an addition of alumina decreases it. Silica additions also decrease the thermal expansion while lime and iron oxide additions have no effect. M.V.K.

Greek magnesite. ANON. *Chem. Trade Jour.*, **88** [2301], 649 (1931).—The most important magnesite areas in Greece are on the island of Euboea and in Macedonia. The Euboean mineral is of a higher grade than the Macedonian, analyzing 95% or more magnesium carbonate, 2.75% calcium carbonate, less than 1% silica, and combined iron and aluminum. It is mostly exported in calcined form. Only small quantities of dead-burned magnesite are produced. M.V.K.

Russian magnesite resources. ANON. *Chem. Trade Jour.*, **88** [2301], 640 (1931); see also *Ceram. Abs.*, **10** [8], 579 (1931). M.V.K.

Molds for silica brickmaking, etc. ANON. *Refrac. Jour.*, **7** [11], 504 (1931).—The "Wright" mechanical brick mold for chrome, fire clay, silica, magnesite, etc., is strongly constructed, requires no skill to operate, has no complicated parts to get out of order, is double sided, making two brick at once, and will average 4000 brick per 8 hr. E.P.R.

Properties of silica brick manufactured from Sharon conglomerate. C. L. FREDERICK, JR. *Jour. Amer. Ceram. Soc.*, **15** [1], 61–67 (1932); for abstract see *Ceram. Abs.*, **9** [3], 191 (1930).

Zirconium blocks for metallurgical furnaces. WILHELM HERRMANN. *Feuerfest*, **7** [10], 146–47 (1931).—The disadvantages of zirconium blocks are brittleness and high cost. Their brittleness exceeds even that of magnesite blocks, but it can be considerably lowered by adding lime and magnesia to the zirconium. The raw materials used are zirconium and caldasite or brasilite. The zirconium mineral is an orthosilicate of the $ZrO_2 \cdot SiO_2$ composition containing 67.2% ZrO_2 and 32% SiO_2. Iron is its chief impurity. Its hardness amounts to 7.5 and its specific gravity, 4.7. The light or dark brown zirconium ore is chiefly mined in Brazil, Madagascar, and New Zealand. Brasilite is the botryoidal or fibrous form of the ZrO_2 mineral and baddeleyite, the crystalline. Brasilite is softer than zirconium and somewhat heavier. Zirkite is a mixture of baddeleyite, brasilite, and zircon. It contains from 70 to 94% ZrO_2, from 5 to 25% SiO_2, and from 2 to 10% Fe_2O_3. The high fusing point (about 3000°C), the small coefficient of expansion (8.4×10^{-7}), and low thermal conductivity of ZrO_2 are advantages for its use in the manufacture of refractory materials and ceramic products, besides a high resistance to sudden temperature changes and corroding action. It is especially resistant to basic, neutral, and acid slag and, with a suitable composition, to strongly alkaline melts. With an increase in the ZrO_2 content, zirconium refractories withstand iron silicates at high temperatures. H. describes some French tests with these refractories. The manufacture of zirconium refractories according to the methods of H. C. Meyer (*Trans. Ceram. Soc.* [Eng.], **18**, 264–75 (1918–19)) is given. M.V.K.

Furnace walls. G. P. REINTJES. Abstracted in *Refrac. Jour.*, **7** [10], 472 (1931); for abstract see *Ceram. Abs.*, **10** [11], 783 (1931). E.P.R.

Mutual influence of furnace lining and refined metal. ANON. *Metal Prog.*, **20** [6], 66–67 (1931).—Most textbooks on refractories give a list of requirements for furnace brick. Infusibility, strength, toughness, and other physical properties are treated. Occasionally "chemical inactivity" is added. In recent days with the intensive study of the available materials the subject of chemical reactivity as applied to slags and refractories has been given increased attention. In formulating a special refractory for a special purpose this property may become the controlling factor. E.P.R.

Lightweight insulated furnace wall. M. H. DETRICK CO. *Power Plant Eng.*, **35** [13], 730 (1931); *Fuel Econ.*, **6**, 719–20 (1930).—There is a definite demand for comparatively thin firebrick walls having several inches of applied insulation. A sectionally supported refractory wall 12 in. thick has been developed which has found economic application for the side walls of boilers, alongside the tubes, and for enclosing water tube-lined furnaces. There are normally 9 in. of tile and 3 in. of insulation composing the 12 in. total thickness. E.P.R.

Low thermal expansion ceramic material. HENRY L. CROWLEY & CO. *Blast Fur. Steel Plant*, **19** [12], 1596–98 (1931); *Ceram. Ind.*, **17** [6], 476 (1931).—A ceramic material possessing the lowest thermal expansion coefficient of any known material, known as Crolite No. 7, has a two-to-one advantage over Invar and a four-to-one advantage at 100° (two-to-one at 1000°) over sillimanite. The coefficient of thermal expansion from 0 to 100°C is 0.9 and 1.2 from 0 to 200°C. Up to 1000°C the coefficient of thermal expansion is 2.7. The thermal expansion curve of Crolite No. 7 is absolutely smooth and uniform. E.J.V.

Refractory coatings. M. L. LITINSKY. *Rev. mét.*, **28** [9], 477–503 (1931); for abstract see *Ceram. Abs.*, **10** [9], 645 (1931). M.V.K.

New product for sealing brick boiler settings. ANON. *Power Plant Eng.*, **35** [8], 480 (1931).—Sealkote dries rapidly after it is applied and the resulting coating remains firm and at the same time pliable and elastic. Asbestos fiber is incorporated in

Sealkote to give additional mechanical strength to the film. A coating thickness of from $^1/_8$ to $^1/_4$ in. is recommended. E.P.R.

Using cast cement in repairing cupola furnaces. PL. CORBELLINI. *Rev. fonderie moderne*, p. 29 (January, 1931); *Giesserei*, **18** [7], 154 (1931).—C. investigated refractory materials of cement type which hardened in less than 24 hr. It was found that a cast cement containing 40 to 42% alumina, 38 to 40% CaO, 4 to 5% SiO_2, and 15% iron oxide was suitable and highly refractory. This material may be used with success not only for mending cupola and annealing furnaces but also for preparing permanent molds for cast alloys. M.V.K.

Upkeep expense on boiler furnace reduced by refractory cement. D. E. BADGER. *Power Plant Eng.*, **35** [7], 416 (1931).—At the Cambridge Electric Light Co., six boilers are installed. Brick are immersed in a batter of cement and then tapped into place. Since 1926, no entire side wall has needed replacement, only repairs. Comparative costs for fire clay and cement are shown in a table. E.P.R.

Durability of grog walls. ANON. *Klei*, **22** [10], 111–13 (1930); *Chim. & ind.*, **24** [2], 364 (1930).—Grog is composed of mullite ($3Al_2O_3 \cdot SiO_2$), tridymite, and a small quantity of the more easily fusible silicates formed by tridymite and fluxes. The advantage of grog (besides its chemical resistance) is its low dilatation. Gas dust and metallic steam, however, act as fluxes. Tridymite melts down and after a certain time only a porous shell of very friable mullite remains. Grog cement gives more protection; it has the same composition although a finer structure. A better protection is obtained with a product composed of high refractory clay which forms with dust an enamel of a double silicate (fusion point over 1100°) which protects grog against new attack. M.V.K.

Testing refractory mortars. H. HIRSCH. *Tonind.-Ztg.*, **55** [91], 1261–62 (1931).—Water glass added to refractory mortar will augment its strength but decrease its refractoriness. W.M.C.

Twenty-First Report of the Refractory Materials Joint Sub-Committee. ANON. Rept. to the Inst. of Gas Engineers; *Gas Jour.*, **192,** pp. 719–23 (1930).—Abstracts are given of a number of papers submitted to the Sub-Committee reporting the results of investigations on refractory materials. (*J.I.S.I.*)

Refractory for laboratory use. MANUEL FELIU. *Quim. Ind.*, **7** [82], 280 (1930); *Refrac. Jour.*, **7** [8], 400 (1931); for abstract see W. HALDENWANGER, *Ceram. Abs.*, **10** [4], 273 (1931). M.V.K.

A further study of the hydrofluoric acid solubility test as a guide to assessing the durability of tank blocks. E. J. C. BOWMAKER AND J. H. PARTRIDGE. *Jour. Soc. Glass Tech.*, **15** [59], 255–62 (1931).—The test will give results reproducible to ±5% of the loss if carried out with care. A block of good quality is represented by a loss in weight under test of less than 20% and a block of passable quality by a loss of between 20 and 30%. In general, blocks which give the best results in practice and by the test have the following characteristics: (1) high content of alumina such that the chemical and physical composition approaches that of mullite, (2) hard fired, and (3) minimum porosity in any given mixture. Tables show approximate constitution of tank blocks tested, their chemical composition, porosity, and corrosion losses. A general description is given of the material tested. For previous study see *Ceram. Abs.*, **9** [5], 353 (1930). G.R.S.

Refractory materials for the induction furnace. J. H. CHESTERS AND W. J. REES. *Jour. Iron Steel Inst.*, **123** [1], 479 (1931).—Linings of magnesia were used in the original horizontal ring induction furnace. In the coreless furnace fireclay and graphite crucibles have been used, but for the production of steel in quantity, durable linings of silica or magnesia with bonds such as boric acid have been developed. Besides refractoriness,

other characteristics required in coreless furnace lining materials are ability to sinter, corrosion resistance, and low firing shrinkage. Grading is an important factor in the ability to sinter and in the lining life. The slag resistance of lining materials may be tested by heating small crucibles filled with slag, by melting steel in larger crucibles filled with slag, or by melting steel in larger crucibles made from the lining material. Microscopic examination of thin slices cut through slagged crucibles shows the nature of the slag attack. In comparing the results obtained with different linings, account must be taken of the melting procedure and of the material melted. The life of linings might be increased by the use of (1) a purer or more refractory material, (2) improved grading and higher sintering temperature, (3) a more refractory bond or the promotion of intercrystallization, either directly or by reaction with other materials, and (4) shaped, tongued, and grooved brick which could be built into crucible form and could be patched with cement as wear developed. See also *Ceram. Abs.*, **10** [12], 845 (1931).

Electric furnaces for melting aluminum. ANON. *Metal Ind.* [London], **38** [14], 357–60 (1931).—Several types of furnaces are described. Crucible furnaces are made of graphite, good quality fire clay, fire-resisting cast iron, or nickel-chromium alloy. Graphite crucibles have poor heat conductivity and owing to radiation of heat, rapidly become friable and break. Fireclay crucibles are cheaper and have a longer life but are sensitive to mechanical strain. Hearth furnaces have magnesite brick with narrow joints for lining the hearth, which prove to be most satisfactory. M.V.K.

BULLETINS

Relative heat transfer through refractories. A. S. WATTS AND R. M. KING. *O. S. U. Eng. Expt. Sta. Bull.*, No. 64; reviewed in *Blast Fur. Steel Plant*, **19** [12], 1596 (1931).—This bulletin covers the development of a practical control method for the determination of relative heat transfer through refractories and includes thirteen tables of data on composition, temperature gradients, insulating values, heat-transfer values, and porosity of a number of samples of brick furnished by many well-known manufacturers of refractories. A critical analysis of the method used in the investigation, made by H. L. Johnston, is included with a theoretical and practical discussion of the data by the authors. E.J.V.

Carbofrax. CARBORUNDUM CO. *Mfrs. Rec.*, **100** [22], 41 (1931).—A booklet on this Carborundum brand of silicon carbon refractory for boiler furnace construction has been issued. Carbofrax withstands temperatures up to a chemical dissociation point of 4000°F, has an average modulus of rupture approximating 900 lb. per sq. in. at 1350°C, and a crushing strength at this temperature in excess of 10,000 lb. per sq. in. In standard spalling tests, Carbofrax shows no loss after 100 coolings and it resists mechanical and flame abrasion. E.P.R.

Pyro-Mortar. QUIGLEY CO., INC. *Pit & Quarry*, **23** [5], 80 (1931); *Brass World*, **27** [11], 237 (1931).—A four-page pamphlet has been issued describing a dry refractory cement for bonding fire brick, reclaiming eroded furnace walls, etc. E.P.R.

Furnace linings and arches. ANON. *Pit & Quarry*, **23** [4], 77 (1931).—McLeod & Henry Co. has issued a 32-page catalogue, No. 231, explaining boiler settings, linings, walls, and arches in respect to the employment of refractory brick. E.P.R.

Graphite in 1930. JEFFERSON MIDDLETON. Bur. Mines, *Mineral Resources U. S.*, 10 pp., 5¢. Data on production, consumption, exports, and imports are given. R.A.H.

PATENTS

Nozzle for molten-metal containers. CLYDE H. MILNER. U. S. 1,832,873, Nov. 24, 1931. A compound nozzle for molten metals comprising a perforate supporting

body of a less refractory material such as fire clay, which in its upper portion contains the seat for the stopper, and a supported bushing of a more refractory material, such as graphite, extending within such perforation from directly below the seat for the stopper to the outlet.

Furnace-wall construction. CLARENCE E. HAWKE. U. S. 1,833,677, Nov. 24, 1931. In a furnace, a combustion chamber, the combustion chamber having side walls and a bridge wall provided with facings of silicon carbide, the silicon carbide facings having many times the thermal conductivity of fireclay refractory material and extending within the zone of the fuel bed and a substantial distance above the zone, and a duct back of the facings through which cooling air is circulated in contact with the rear walls of the facings throughout the major portion of the area thereof, a portion of the facings above the zone being imperforate, and a portion thereof within the zone being perforate, the duct delivering to the perforate portion whereby the cooling air which circulates through the duct is conducted to the fuel bed through the perforate portion in a highly preheated condition.

Method of operating furnaces. CLARENCE E. HAWKE. U. S. 1,833,712, Nov. 24, 1931. The method of protecting walls of silicon carbide from oxidation and destruction in a metallurgical furnace wherein they are employed at a temperature above which silicon carbide refractories ordinarily oxidize, which comprises the step of conducting the heat away from the exposed face of the silicon carbide at a rate sufficient to insure the maintenance thereover of a protective layer congealed thereon from basic slags and metal oxides coming into contact therewith and to protect the silicon carbide from destructive reaction therewith.

Making ceramic compositions. THOMAS S. CURTIS. U. S. 1,834,515, Dec. 1, 1931. The process of making a clay-product strengthening ceramic composition comprising heating a crystalline mineral body of cyanite to a temperature sufficient to change the structure of attached minerals to fracture the minerals readily away from the cyanite, but not exceeding approximately 1800 °F, to commence elongation of the cyanite crystals until the cyanite crystals elongate and the attached minerals are easily separable therefrom, and then proportioning the pure cyanite with the attached adulterating minerals to control the fire-shrinkage factor of a mass in which the composition is used.

Furnace wall construction. FRANK B. BIGELOW. U. S. 1,835,001, Dec. 8, 1931. In a furnace wall, the combination of a metal frame, hanger brick carried by the frame, fluid-filled pipes positioned inwardly of the furnace with relation to the frame, and lining brick demountably carried on the hanger brick and covering the pipes.

Heat-exchange device. ARTHUR G. MCKEE. U. S. 1,835,074, Dec. 8, 1931. Stove-checker supporting units, each comprising a single column supporting a concentrically loaded cap out of contact with adjacent supporting members.

Aluminum silicon alloys. HANS SCHORN. U. S. 1,835,244, Dec. 8, 1931. Producing aluminum silicon alloys according to an uninterrupted electrolytical melting process of manufacturing aluminum in a fluoride bath without reduction of silicic acid, consisting in modifying the process by adding to aluminum in the nascent state, uncombined silicon in an amount in accordance with the desired proportion thereof in such alloy, whereby the resulting product becomes a fine-grained alloy.

Sectional furnace wall. DAVID S. JACOBUS. U. S. 1,835,873, Dec. 8, 1931. A furnace wall comprising a plurality of fixed vertically disposed supports, horizontal supporting members connected to the fixed supports and spaced apart vertically thereon, a group of tile supports for each horizontal supporting member and spaced apart thereon across the wall, each tile support having a vertically disposed bulbed rib thereon and tile having recesses to engage the bulbed rib, each tile support having a projection beneath the row of tile connected to the rib to support the row, each tile support

having a vertically disposed projection on its outer edge, and filling material between each pair of tile supports and held in place by the vertically disposed projections to form with the supports a substantially continuous backing plate for the wall.

Sectional furnace wall. DAVID S. JACOBUS. U. S. 1,835,945, Dec. 8, 1931. A furnace wall having a support, a plurality of wall tile carried on the support inwardly thereof and each having vertically disposed grooves in the face thereof, and facing tile having projections disposed in the grooves.

Furnace for roasting zinc blende. GEORG BALZ. U. S. 1,836,002, Dec. 15, 1931. In a furnace for roasting zinc blende, in combination, a plurality of circular refractory disks placed in spaced relation to form intervening chambers, means for rotating alternate disks, wedge-shaped vanes positioned on the lower surfaces of the disks, and scrapers positioned on the disks for destroying accumulations of the blende.

Furnace wall. EUGENE A. BROOKS. U. S. 1,837,146, Dec. 15, 1931. A monolithic furnace wall composed of plastic, fire-resisting material having a plurality of indentations produced in the wall while the material is plastic and so arranged as to permit the furnace heat to penetrate the entire mass to promote permanent setting.

Production of refractories. VEREINIGTE STAHLWERKE AKT.-GES. Brit. 360,572, Nov. 18, 1931.

Manufacture of brick, etc. J. G. STEIN & CO., LTD., AND J. F. HYSLOP. Brit. 361,166, Nov. 25, 1931.

Manufacture of compositions comprising ceramic bonded alumina granules. NORTON CO. Brit. 361,167, Nov. 25, 1931.

Manufacturing refractory materials. W. W. TRIGGS. Brit. 361,286 and 361,290, Dec. 2, 1931.

Ceramic materials. Z. A. MIRFIELD-MERFIELD. Australia 23,090, Oct. 18, 1929. Ceramic materials are made by preparing one or more calcines by wet-milling suitable material containing an alkaline earth metal, adding boric acid, removing excess water, kneading and firing under suitable conditions, wet-milling the calcine or calcines with kaolin and (or) ball clay, removing excess water, molding, and firing. Be, Zn, Ti, Zr, Ce, or Th may be incorporated in the mixture. (*C.A.*)

Terra Cotta

Simplification of the ring method for determining glaze stresses. H. E. DAVIS AND R. L. LUEDERS. *Jour. Amer. Ceram. Soc.*, **15** [1], 34–36 (1932).

Automatic device for producing a curve coördinating shrinkage and drying loss. H. SPURRIER. *Jour. Amer. Ceram. Soc.*, **15** [1], 84–86 (1932).

Experiments on acid-resistance tests of ceramic materials. W. DAWIHL. *Tonind.-Ztg.*, **55** [91], 1259–60 (1931).—Acid-resistance of ceramic materials depends not only on the chemical composition but also on the porosity and form of pores. Samples of Zettlitz kaolin fired at cones 05, 8, and 17 were boiled in 20% sulphuric acid. The low-fired bodies were attacked most. Porous and nonporous bodies fired at the same temperatures gave corresponding results. W.M.C.

Weather-stable building ceramics. HANS ESKA. *Sprechsaal*, **64** [36], 661–62 (1931).—E. discusses means of obtaining weather-stable ceramics. The method is based on the sintering of the surfaces of the products at low temperatures. The air-dried molded objects are sprinkled with concentrated solutions of sodium, potassium, and calcium chloride or boric acid. The best results are obtained with solutions of sodium salts. The objects are fired in muffle kilns at 940 to 1000° with a changing atmosphere, *i.e.*, oxidizing and reducing. A table is given showing all the color tones obtained. M.V.K.

Firing roofing tile. ANON. *Brit. Clayworker*, **40** [474], 258–59 (1931).—The firing of roofing tile is easiest in downdraft periodic kilns or, if the output is sufficiently large, continuous kilns are equally satisfactory. A flat arched kiln has certain advantages. Careful drying with clean air is essential to avoid "kiln-white" and cracking. It is a mistake to have too many preheating chambers and it is never wise to carry the gases forward at less than 120°C. A sufficient length of "hot kiln" before and after the chamber which is actually being fired is important to prevent heating and cooling too rapidly or wastage will be excessive. R.A.H.

Hints on making sanitary ware. ANON. *Brit. Clayworker*, **40** [474], 249–51 (1931).—Sanitary ware is chiefly made of fire clay which is coated with a white engobe and a leadless glaze, both of which may be applied to the unfired article. The grog used should be fired at least 3 cones higher than the ware, should be sharp and angular, and should not exceed 0.16 in., not including dust. The porosity of the biscuit ware should not exceed 10%. An electrolyte should be used that will produce a good slip with only 15% water. If a fine clay layer on the inside of a mold prevents the water from being absorbed, a coarser clay should be used. Drying troubles often result from lack of control of humidity, pouring the slip too rapidly, too coarse or fluid a slip, etc. The risk of discoloration of engobe can be reduced by fine grinding and thorough mixing. Blue stain or cobalt chloride nitrate will whiten a faintly yellowish engobe. The shrinkage of the engobe must be the same as that of the body. R.A.H.

Plant for manufacturing roofing tile. H. DENDL. *Tonind.-Ztg.*, **55** [87], 1208–1209 (1931).—A plant with a daily output of 14,000 flat roofing tile is described. Illustrated. W.M.C.

Development of the skyscraper. DOUGLAS HASKELL. *Atelier*, pp. 262–66 (Oct., 1931).—Some of the modern skyscrapers show an interesting surface treatment. The architect considers the façade as a curtain and by folding the material gains a greater amount of window space. The play of light and shadow in such a treatment strengthens the vertical emphasis and gives a softer effect. (*D.I.*)

Mechanization of material. FRANK LLOYD WRIGHT. *Form*, pp. 341–49 (Sept., 1931).—Architectural style is determined by materials at hand. Each is taken up in turn: wood, glass, steel, and iron. Their structural qualities as applied to architecture and ornament are described. (*D.I.*)

Impressions of the Paris Colonial Exposition. ELY JACQUES KAHN. *Amer. Architect*, pp. 34–38 (Oct., 1931).—K. gives his impressions of the Colonial Exposition. Contrasts between the functionalist buildings and the more native constructions were decided. Some of the native designs with a tendency to the geometric should be a source of inspiration to the modern architect and designer. (*D.I.*)

New architecture in Japan. RICHARD J. NEUTRA. *Form*, pp. 333–40 (Sept., 1931).—Pictures are given of recent office buildings, residences, bazaars, restaurants, and stadiums with a short account of the materials, their difficulties with building laws, taxes, etc. See also *Ceram. Abs.*, **10** [7], 509 (1931). (*D.I.*)

PATENT

Forming clay products having spiral centers. MAURICE A. KNIGHT AND ANDREW BAIRD. U. S. 1,833,465, Nov. 24, 1931. In combination with mechanism for preparing and delivering plastic material, means for forming products of plastic material having spiral centers comprising a stationary shaper secured to the delivery portion of the mechanism having a bore for shaping the contour of the products and a rotatable member arranged substantially centrally of the bore of the shaper for forming the spiral centers of the products, and means for driving the rotatable member at variable speeds.

White Wares

Auxiliary fluxes in ceramic bodies. PAUL F. COLLINS. *Jour. Amer. Ceram. Soc.*, **15** [1], 17–27 (1932).

A cone nine vitrified floor-tile body. F. A. KIRKPATRICK AND W. E. WILLIAMS. *Jour. Amer. Ceram. Soc.*, **15** [1], 28–33 (1932).

Color formation in raw lead glazes. D. TE HUI SHAW. *Jour. Amer. Ceram. Soc.*, **15** [1], 37–58 (1932).

Ceramic body from Mojave desert. T. S. CURTIS. *Chem. Met. Eng.*, **38** [11], 654 (1931).—Properties are given of various types of whiteware products made with a new ceramic raw material. The durability and color have been improved in many types of white ware by the use of this raw material. G.R.S.

Acid-resisting porcelain from calcium fluorides. ANON. *Chem. Trade Jour.*, **89** [2311], 230 (1931).—A paste containing 75 parts natural calcium fluoride and 25% artificial calcium fluoride is dried, pressed, and redried at 100°. In this state it can be shaped as desired. The firing temperature for a dense impermeable body should be about 1250°. The product is perfectly neutral and has the same white, nearly translucent appearance as ordinary porcelain. It has great resistance to thermal shock, is heat stable, and acid resisting. It can be made up into apparatus of any desired shape because shaped pieces can be joined perfectly by cementing with the original paste, then drying, and firing. M.V.K.

Some notes on the manufacture of high-tension insulators. FRED D. CROWLEY. *Trans. S. African Inst. Elec. Eng.*, **22**, 122–31 (1931).—Characteristics necessary in a good insulator are reviewed and an attempt is made to explain some of the operations necessary to produce a satisfactory product. The materials generally used are English ball or plastic clay, kaolin or china clay, flint, and feldspar. The functions of each constituent and the three methods of manufacture of high-tension insulators, *i.e.*, plunging or pressing, jiggering, and casting are described. (*C.A.*)

Electrical strength of porcelain. J. O. KRAEHENBUEHL AND C. W. PARMELEE. *Trans. Amer. Electrochem. Soc.*, **59**, 409–25 (1931).—The puncture track in a specimen of porcelain is largely a matter of chance and depends on flaws in the material. Hence a large number of samples must be tested in order to obtain a proper estimate of quality. A statistical study has been made of the results obtained with a number of samples prepared under controlled conditions. (*B.C.A.*)

Pressing small porcelain parts on a production basis. L. I. SHAW. *Ceram. Ind.*, **17** [6], 456–57 (1931); for abstract see *Ceram. Abs.*, **9** [3], 210 (1930). W.W.M.

Development and present status of extra high-tension insulators in Japan. TAKEO MIYAGUCHI. *Proc. World Eng. Cong.* [Tokyo, 1929], **21**, 61–71 (1931).—M. discusses the composition of porcelains for this use. (*C.A.*)

SiC as impurity in porcelain. SÖREN BERG. *Chem. Zentr.*, **102** [6], 893 (1931); for abstract see *Ceram. Abs.*, **10** [9], 649 (1931). J.G.T.

Franco-German-Czechoslovakian porcelain agreement. ANON. *Pottery Gas.*, **56** [654], 1677 (1931).—An agreement between the French, German, and Czechoslovakian porcelain factories by which a minimum price for porcelain on these three markets was established has been signed. Government confirmation is required to put it into force. E.J.V.

BOOK

Ten Generations of a Potting Family (Adams). W. TURNER. xxvi + 135 pp. Reviewed in *Times Lit. Supp.*, **30**, 707 (1931); for abstract see *Ceram. Abs.*, **11** [1], 44 (1932). H.H.S.

PATENTS

Cap tile. LÉON V. SOLON. U. S. 1,833,442, Nov. 24, 1931. A cap tile, the front face of which presents upper and lower substantially vertical parallel finished surfaces adapted to be exposed when in use and off-set relative to each other, and an inclined substantially plane connecting surface.

Corner tile. JAMES C. DE VOL. U. S. 1,833,672, Nov. 24, 1931. A metal corner tile comprising a suitably curved body portion having rearwardly extending sides and top and bottom flanges terminating in fingers adapted to be embedded in cementing material, the fingers having vertical aligned holes therein for accommodating connecting members.

Porcelain. ROBERT TWELLS. U. S. 1,834,880, Dec. 1, 1931. A green porcelain body containing lepidolite mica as a constituent.

Pottery topping machine. DAVID L. ROULEAU. U. S. 1,836,817, Dec. 15, 1931. In a pottery topping machine, a rotatable chuck for supporting an article of pottery, a tool adjustable toward and away from the axis of the chuck and engageable with the article of pottery, and a variable speed motor for rotating the chuck, whereby the speed of rotation of the article of pottery at the point of engagement of the tool may be regulated.

Dies for use in manufacture of tile for walls, fireplaces, etc. J. H. ASHWORTH AND WOODS TILERIES (Hanley), LTD. Brit. 360,674, Nov. 18, 1931.

Electric insulators. GENERAL ELECTRIC CO., LTD., AND S. W. RICHARDS. Brit. 360,708, Nov. 18, 1931.

Insulators. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 361,080, Nov. 25, 1931.

Decorating pottery ware. W. J. MILLER. Brit. 361,358, Dec. 2, 1931.

Applying appendages to pottery ware. W. J. MILLER. Brit. 361,359, Dec. 2, 1931.

Feeding clay slip to molds and other appliances in the manufacture of pottery ware. W. J. MILLER. Brit. 361,360, Dec. 2, 1931.

Equipment and Apparatus

Air-operated controller. BRISTOL CO. *Chem. Met. Eng.*, **38** [11], 669 (1931).—For the control of pressure and temperature the "Free Vane" method of pilot control is used. The vane, which swings about a fixed point, is positioned by the sensitive element of the controller. A diagram shows the operating principle. A major advantage of the new system is the frictionless connection between the sensitive and controlling elements. The device is simple and gives results of extreme accuracy. Instruments are inclosed in a two-part cast-aluminum case containing either a spring-wound or a synchronous electric clock. G.R.S.

New flow instruments. C. J. TAGLIABUE MFG. CO. *Chem. Met. Eng.*, **38** [11], 670 (1931).—Instruments are available for recording and controlling (or recording alone) the flow of both liquids and gases. A sketch shows the construction of the manometer and orifice used with the new meter and controller. G.R.S.

Oil-pressure system for hydraulic presses. HYDRAULIC PRESS MFG. CO. *Elec. World*, **98** [23], 1024 (1931).—An oil-pressure system developed for the operation of the HPM hydraulic presses of the general utility type not only allows for complete control over press performance but increases the speed at which the press works. G.R.S.

Pyrometer. LEEDS & NORTHRUP CO. *Brass World*, **27** [11], 237 (1931); for abstract see *Ceram. Abs.*, **10** [11], 793 (1931). E.P.R.

Ratio combustion meter. BAILEY METER CO. *Chem. Met. Eng.*, **38** [11], 671 (1931); see also *Ceram. Abs.*, **10** [12], 851 (1931). G.R.S.

Water-level indicator. SCHUTTE AND KOERTING CO. *Chem. Met. Eng.*, **38** [10], 605 (1931).—This system makes use of a transmitter cylinder connected, top and bottom,

to the tank. Within the transmitter are a number of electrodes which make electrical contact with the water at different heights. Electrodes are connected through relays to a number of indicating lights which show the level of the water. G.R.S.

Magnetic separator. MAGNETIC MFG. CO. *Chem. Met. Eng.*, **38** [11], 671–72 (1931); see also *Ceram. Abs.*, **10** [11], 793 (1931). G.R.S.

Portable gas analyzer. CHARLES ENGELHARD, INC. *Gas Age-Rec.*, **68** [22], 800 (1931); for abstract see *Ceram. Abs.*, **10** [11], 795 (1931). E.J.V.

Continuous filter. BARTLETT HAYWARD CO. *Rock Prod.*, **34** [25], 90 (1931); *Chem. Met. Eng.*, **38** [10], 602 (1931).—The oscillating continuous filter (Genter type) consists essentially of individual tubular elements arranged in squirrel-cage fashion about a central shaft which is open at one end. The cantilever elements forming bars of the squirrel cage act as filter elements and also as oscillating, agitating arms as they work their way through the sludge bath contained in a tank into which the lower elements are submerged. Its operation and advantages are described. Illustrated. W.W.M.

Dust filters. W. W. SLY MFG. CO. *Abrasive Ind.*, **12** [12], 33 (1931); for abstract see *Ceram. Abs.*, **10** [12], 852 (1931). E.P.R.

Formulas applicable to air separation. A. W. CATLIN. *Rock Prod.*, **34** [25], 46–48 (1931).—C. gives working formulas and flowsheet diagrams for an open-circuit and two types of closed-circuit air separation installations. Formulas for determining load, feed, and efficiency are given. W.W.M.

Screen mounting. STEPHEN, ADAMSON MFG. CO. *Chem. Met. Eng.*, **38** [10], 606 (1931).—A new mounting for vibrating screens consists of a single mechanical unit known as a "stabilizer" which operates without springs. G.R.S.

Measuring stiffness of clay. D. H. ROWLAND AND H. L. GALLOWAY. *Ceram. Ind.*, **17** [6], 466–67 (1931).—The authors describe an instrument and process for determining the plastic properties of a clay or body. The device embodies the following features: (1) It is constant in calibration. (2) In case it is accidently thrown out of adjustment it can be recalibrated accurately year in and year out. (3) The human element is eliminated as far as possible. (4) The various readings are recorded automatically both in regard to values obtained and time. A layer of the plastic material is automatically pressed by one piston against another and the transmitted pressure is recorded. The accuracy is such that it will detect considerable change in plasticity before any difference can be detected with the fingers. The chief source of error is in the thickness of the test piece, but this has been practically eliminated by the sampling device which the authors developed. This instrument is being used successfully in the control of plastic bodies in the plant of the Locke Insulator Co., Baltimore, Md. W.W.M.

Electric proportioning control. MINNEAPOLIS-HONEYWELL REGULATOR CO. *Chem. Met. Eng.*, **38** [10], 604 (1931).—For controlling temperature, pressure, humidity, liquid level, flow, speed rates, and other variable functions by motor-operated valves, etc., a motor-operated device has been constructed to move in proportion to the change in the variable. Diagrammatically illustrated. G.R.S.

Automatic polishing. R. G. GUTHRIE. *Metal Prog.*, **20** [6], 59–63(1931).—Many of the newer types of apparatus and methods for grinding and polishing metals for metallographic examination are given. E.P.R.

Belt conveyer theory and practice. I. Capacity, speed, and size of lumps. G. F. DODGE. *Rock Prod.*, **34** [25], 80–82 (1931).—D. discusses belt conveyers, giving a chart for determining proper speed and width for a given capacity. A table containing data on construction, strengths, and weights of belts is included. Formulas for belt capacity and tables of limiting sizes of material which can be conveyed and limiting speeds of belts are also given. W.W.M.

Tunnel driers with moving charges. C. LOESER. *Sprechsaal*, **64** [44], 807–10 (1931).—The first satisfactorily working tunnel driers were built by Moeller and Pfeifer about 1890. A detailed description of a drying plant is given using the principle of Moeller and Pfeifer. Three zones are distinguished in a tunnel drier according to the distribution of heat and the removal of the moisture from the product. Illustrated. W.M.C.

All-steel mill. PATTERSON FOUNDRY & MACHINE CO. *Chem. Met. Eng.*, **38** [11], 470 (1931).—Welded, all-steel construction is used in the Type AS pebble mills for either belt or motor drives. These mills are offered in nine sizes ranging from 80 to 2100 gal. G.R.S.

Small speed reducers. W. A. JONES FOUNDRY & MACHINE CO. *Chem. Met. Eng.*, **38** [11], 671 (1931).—For small motor drives in ratios from 12 to 72, two new double-reduction speed reducers have been developed. The initial reduction is made between double helical gears. The low-speed reduction consists of an accurately generated Maag pinion and gear. G.R.S.

Environment in electric motor selection. H. M. FRENCH. *Maintenance Eng.*, **89** [12], 602–605 (1931).—The desirability of using special enclosed types of motors in dusty, dirty, or gaseous plant atmospheres where the dust is corrosive, conducting, explosive, abrasive, or magnetic is explained. Some such dusts are coal, coke, graphite, sand, stone, emery, flour, starch, grain, bronze, aluminum, iron, and steel. Cooling of such enclosed motors is accomplished by internal fans or by separate external blowers. J.L.G.

Lubricating systems for special applications. FRED H. LOW. *Maintenance Eng.*, **89** [12], 599–601 (1931).—Several special applications of lubrication for both heavy and light machinery are explained. J.L.G.

Power losses in group drives. ROBERT W. DRAKE. *Maintenance Eng.*, **89** [12], 595–98 (1931).—D. discusses and gives figures for power losses in group drives considering the following six sources of loss: (1) lineshaft bearing friction, (2) countershaft bearing friction, (3) belt windage, (4) pulley windage, (5) creep and slip, and (6) unaccounted-for losses. J.L.G.

Does your motor fit your job? JAS. B. HOLSTON. *Maintenance Eng.*, **89** [12], 582–85 (1931).—H. discusses the seven distinct standard types of a.-c. motors and the kind of job which each will perform most efficiently. Representative curves of characteristics are given for each type as well as a list of the proper applications for each type. J.L.G.

Grinding plant research. I. Tube mill grinding. WILLIAM GILBERT. *Rock Prod.*, **34** [24], 39–42 (1931).—G. outlines the data on cement-mill grinding which were gathered by the joint research committee of the principal British cement manufacturers and gives the methods of collecting them. Fundamental formulas, general principles relating to grinding in ball and tube mills, and methods of determining the best speed for a tube mill and of calculating the required horse power are given. W.W.M.

Equipment exhibit. ANON. *Céramique*, **34** [521], 201–13 (1931).—A description of ceramic machinery, kiln plans, plant layouts, etc., is given by the manufacturers of ceramic equipment. A.E.R.W.

CIRCULARS

Method and cost of quarrying limestone at the quarry of the Trinity Portland Cement Co., Fort Worth, Tex. J. WILLIAM GANSER. Bur. Mines, *Information Circ.*, No. 6513. One of a series of papers describing equipment, practice, and costs at cement plant quarries throughout the U.S. See also *Ceram. Abs.*, **11** [1], 48 (1932). R.A.H.

Method and cost of quarrying, crushing, and grinding limestone at the Catskill plant

of the North American Cement Corp. W. J. FULLERTON AND A. W. COX. Bur. Mines, *Information Circ.*, No. 6522, 15 pp. This is one of a series of papers which describes practice and equipment and gives costs. R.A.H.

Mining and crushing methods and costs at the Tiffin limestone quarry of the Thurber Earthern Products Co., Fort Worth, Tex. D. C. BOLIN. Bur. Mines, *Information Circ.*, No. 6531, 10 pp. (Free.) This paper describes quarrying methods and costs at stone quarries throughout the U.S. for the purpose of disseminating technical information regarding methods used. R.A.H.

PATENTS

Control mechanism for hydraulic presses. WALTER ERNST. U. S. 18,287, Dec. 15, 1931 (reissue). A control mechanism adapted to be operatively connected to a hydraulic circuit including a reversible variable discharge pump and a hydraulic press having a movable platen; the mechanism comprising a device adapted to occupy three positions, means for moving the device from the first to the second position to cause the pump to discharge so as to produce the pressing movement of the platen, pressure-controlled means for thereafter moving the device from the second to the third position to reverse the discharge of the pump and produce the return movement of the platen, and automatic means for thereafter moving the device from the third to the first position to place the pump in a neutral position.

Filter press. MEYER WILDERMAN. U. S. 1,833,101, Nov. 24, 1931. A filter press comprising double filter plates, each double filter containing single filter plates with individual rims providing a space within the double filter plates for the filtrate, in which the single filter plates of the double filter are provided with ribs which strengthen them, the ribs projecting into the spaces within the double filter and contacting with the ribs on the opposite plate of the double filter in order to support the single plates against the pressure of the solution being filtered.

Regulator, etc. ALFRED E. STACEY, JR. U. S. 1,833,383, Nov. 24, 1931. In a regulator, etc., the combination of a sensitive element adapted to expand and contract, a movable controlling arm mounted to swing about a fulcrum point, means coöperating with the controlling arm for effecting regulation, the sensitive element being connected to the controlling arm near the fulcrum point for moving the arm, an adjusting device by which the point of connection between the sensitive element and the controlling arm is shifted for changing the ratio between the movements of the sensitive element and the controlling arm, a lever to which the sensitive element is operatively connected, and means for adjusting the lever.

Drying kiln. HAROLD F. HAGEN. U. S. 1,833,397, Nov. 24, 1931. A kiln comprising a drying room, means for circulating air through the drying room including a pressure fan and supply and return ducts connecting the fan and the drying room, and a pressure chamber through which the air passes from the supply duct to the drying room comprising closely spaced, uniformly perforated partitions to afford a substantially uniform pressure over all parts of the pressure chamber, the total area of the perforations in the supply side of the chamber being less than in the drying-room side.

Molding machine. JOHN B. BLEWETT. U. S. 1,834,119, Dec. 1, 1931. In a molding machine, a mold, a stationary core means for supplying material to the mold, and means insertable into the space between the mold and the core for distributing the material in the mold as it is supplied thereto.

Air classifier. ALBERT H. STEBBINS. U. S. 1,834,981 and 1,834,982, Dec. 8, 1931. (1) A horizontally extending air classifier comprising an elongated container having corrugated upstanding side walls disposed in spaced relation to each other to form a serpentine air passage between them, means for advancing material-laden air through the

serpentine passage, the passage being constructed to deflect the stream of material-laden air laterally back and forth while traveling therethrough to cause the heavier particles to move out of the path of the air stream into the channels of the corrugated walls under the combined action of centrifugal force and momentum, a series of collecting hoppers arranged along the lower wall of the container and each provided with an air inlet opening for producing a stream of air passing upwardly within the hopper through the falling materials, and a deflecting plate adjacent each of the openings for directing the stream of air into the central portion of the hopper. (2) An air classifier comprising, in combination, a downwardly extending receptacle, means for delivering an air stream carrying the materials to be separated into the receptacle with a rotative movement that imparts a rotative whirling movement to the volume of air within the receptacle, including an air-inlet pipe extending spirally downwardly about the receptacle and through a side wall thereof to project inwardly from the inner wall of the receptacle and adapted to guide the stream of material-laden air into the receptacle and in a downwardly spiral path therein, and means for removing air from the upper end of the receptacle.

Magnetic separator. FRED R. JOHNSON. U. S. 1,836,252, Dec. 15, 1931. In a magnetic separator, an inclined frame, a spaced series of pole pieces disposed across the frame, and a spaced series of magnetized rotors journaled transversely of the frame beneath the pole pieces and spaced therefrom.

Kilns, Furnaces, Fuels, and Combustion

Investigation of the technical efficiency of kilns and driers. ANON. *Brit. Clayworker*, **40** [474], 248–49 (1931).—The 8th annual report by the French Syndicate of Clayworkers discusses the efficiency of some modern artificial driers. The majority of the twenty-two kilns examined are equipped with automatic stokers which permit more precise regulation, more uniform firing, economy in coal, and a larger proportion of best quality goods. Coal consumed is less than 6.8% of the fired weight in 20 out of 22 kilns and less than 5% in 5. A consumption of 6.8% corresponds to 4.1 cwt. per 1000 brick weighing 3 tons. Firing and cooling processes can be speeded up except for certain critical temperatures. Three kilns which had a fire travel in 24 hr. of 44 ft., 113 ft., and 78 ft., respectively, were satisfactorily cooled in zones 81 ft., 156 ft., and 65 ft. in 44, 30, and 20 hr., respectively. Three tunnel driers and two chamber driers were studied. In the two chamber driers, clays similar in character were treated. The colloidal water present in them is 18 and 16%, respectively, water of interposition 13½ and 14%, and shrinkage 8.1 and 8.7%. The laboratory studies indicated the safe drying time to be 51 and 48 hr., respectively. Actual practice shows that the one drier was taking 14 days for the drying process and the second less than 3 days. The main difference found was that the circulation of air was correct in the one case and incorrect in the other. In the case of the tunnel driers, two were heated by aero-condensers and a flue for returning a portion of the moist air, and the third was utilizing the combustion gases from a coke furnace. The colloidal water of the clays used was 19.6, 18, and 23.6%, the water of interposition was 9.2, 10.5, and 18.6%, and the shrinkage was 10, 8, and 6.1%. The ascertained time of drying was 164, 30, and 6 hr., respectively. In the first case the drying time was reduced to 84 hr. by decreasing the size of the return moist-air flue. In the second and third cases the time and apparatus were adjusted to result in better drying of the ware as well as in reduction of total drying time. R.A.H.

Firing terra cotta. H. SPURRIER. *Fuels & Fur.*, 9 [5], 615–18 (1931).—Firing is considered to be the most important step in the manufacture of terra cotta, and great care must be taken to insure proper conditions. Large kilns make for fuel economy but as the size of the kiln increases, there is greater difficulty in getting even heat distribu-

tion. During firing, the ware suffers a considerable loss in weight mainly through the removal of the water of combination of the clay. Most clays also give off a large volume of occluded gases at a moderately low temperature. By far the greater part of the total firing loss takes place in the early stages or dehydrating period. The mechanically held water is removed first and after about 120°C the clay begins to decompose and give up its "combined" water. The first stage is commonly called a "mechanical water-smoking" and the latter, a "chemical water-smoking." Oxidation sets in before 700°C although the chemical water-smoking continues to this temperature. During oxidation the carbonaceous matter is burned and the sulphides are decomposed. It is important that all carbon should be burned out of the body before the iron sulphate, formed by the decomposition of iron sulphide, begins to decompose. Otherwise black spots are liable to ruin the ware. The removal of carbon is more difficult in red firing clays than in the buff variety. The last stage in the firing of the ware is the vitrification period. It is good practice to give enough time to this period to enable chemical reactions, possible at the final temperature, to go to completion, as by this practice greater stability is secured. Care should be taken not to cool the ware too quickly. A.E.R.W.

Melting metal by burning glass. ANON. *Metal Ind.* [London], **38** [22], 547 (1931).—A powerful furnace using an elliptical mirror with a strong electric arc-lamp as a source of light instead of the sun was constructed in Sweden. A heat strong enough to melt a metal with a melting point of about 2100°C was obtained. In another test, the mirror was focused on a piece of platinum which melted in 4 min. M.V.K.

Insulation of kilns and drying installations. OTTO TH. KORITNIG. *Giess-Praxis*, pp. 82–85 (March, 1931); *Giesserei*, **18** [21], 431–32 (1931).—The coefficient of thermal conductivity of an insulating material determines its use. The coefficients for every substance at different temperatures can be grouped in a system of coördinates into a curve of thermal conductivity figures. The following insulating materials are suitable in practice: peat, sawdust, straw, and cell concrete for temperatures of −25 up to 10°, vegetable and tar fibrous materials from 10 to 100°, slag and cork from 100 to 150°, cell concrete up to 400°, magnesia, diatomaceous materials, aluminum foil, and air from 500 to 600°, and grog brick, silica brick, Dinas, and magnesite blocks from 800 to 2000°. Eighty-five per cent magnesia has the most suitable coefficient of thermal conductivity. See also *Ceram. Abs.*, **9** [9], 764 (1930). M.V.K.

Heat technical calculations of annular kilns. R. KNETSCH. *Ziegelwelt*, **62** [13], 177–80 (1931); *Feuerfest*, **7** [10], 156 (1931).—K. discusses the following points: (1) calculation of the most efficient firing for coal consumption, (2) investigation of the burning properties of the charge materials, (3) fixing the temperatures in separate zones, (4) determination of the theoretical quantity of coal, (5) calculation of the outside temperature of the masonry, and (6) necessary quantity of air. M.V.K.

Woodall-Duckham circular tunnel kiln. A. GAMOT. *Céramique*, **34** [522], 236–44 (1931).—The circular form and the disposition of the heating and recuperating circuits are features of the Woodall-Duckham kiln of which four are in commercial use. One of these is described in detail with diagrams. A feature is the flexibility in regard to firing curves and the possibility of securing uniform temperatures. These results are not due to the circular form but to arrangement of heating and cooling ducts. The circular form was adopted because (1) a 73 m. kiln could be installed in a space whose longest dimension was 30 m., whereas a straight 73 m. kiln would require a clear 85 m., (2) it dispensed with the handling of kiln cars, (3) it required fewer wheels, (4) the loading and unloading is done at one point which can easily be enclosed, and (5) the kiln is absolutely tight and the sand seal needs no replacing of sand. Sanitary ware can be fired with a semimuffle arrangement. One kiln has been operating steadily for three years. Savings in labor, fuel, and saggers are shown. A.E.R.W.

Circular tunnel kilns. BARABASH. *Ceramics & Glass*, **7** [7–8], 43–45 (1931).—B. describes the latest types of circular tunnel kilns used in the U.S. and England. M.V.K.

Kilns for common and hard-fired brick. C. HEUER. *Tonind.-Ztg.*, **55** [88], 1220–22 (1931).—Periodic kilns and ring kilns of different types are described and a diagram is given showing the heat balance of a ring kiln. W.M.C.

Design of flues and stacks. JOHN W. ROMIG. *Ceram. Ind.*, **17** [6], 462–64 (1931).—R. presents a technical discussion of stacks and flues. Formulas for calculating required dimensions under various conditions are given and illustrated by computations from assumed data. He shows calculations for coal, fuel oil, and natural gas installations and suggests the adaptation of design for all fuels. W.W.M.

Use of fuel oils in the ceramic industries. A. LEDUC. *Céramique*, **34** [522], 225–36 (1931).—(*1*) *Fuel Oils.* The principal properties of fuel oils are density, calorific value, viscosity (and its inverse, fluidity), inflammability, and percentage of water, sulphur, asphalt, and paraffin. The important oils are "fuel oil" and "light fuel oil," the latter being made by mixing the former with gas oil. The characteristics of gas oil, Diesel oil, light fuel oil, fuel oil, and bunker oil are listed. Fuel oil should be preheated to at least 40°C in cold weather. It is necessary to reach the "critical viscosity" between 8° and 3.5° Engler. A sulphur content of 1.5% will give no trouble. (*2*) *Oil Burners.* Oil burners can be divided into two classes, vaporizing and atomizing. The former has a limited usefulness. In the latter, atomization is secured by mechanical means, by steam, by air at high, medium, or low pressures, or by rotating mechanisms. L. describes these types and discusses their advantages and disadvantages. (*3*) *Kilns and Furnaces.* Up to the present time oil burners have been used in kilns designed for coal. Kilns specially designed for oil, however, will soon be in use and provide further economies. (*4*) *Commercial Results.* L. gives detailed data on the use of fuel oil in firing porcelain, sanitary ware, faience, brick, etc., in France and England. Particular attention is paid to the use of oil in an electrical porcelain plant at Burslem, North Staffordshire, and diagrams of burners and fire boxes are given. Oil costs per unit of product were 5.4F while coal costs were 6.4F. The use of oil in a tunnel drier near London, England, is also described. A.E.R.W.

Automatic burning of fuel oil. C. C. CUSTER. *Power Plant Eng.*, **35** [14], 747–50 (1931).—Fuel oils are of two classes, (1) distillates and (2) residuals. Distillates comprise the oils of 26 gravity Bé and above which may be distilled "over the top" and separated into various grades up to 40 to 42 Bé. Residuals are the oils below 26 Bé down to as low as 12 to 14 Bé. These are too heavy to be distilled "over the top" and must be purified by filtration and other processes. The crude oils of asphaltum base are the best producers of good-quality heavy fuel oils. The heavier paraffin base crude oils produce fuel oils which are not of proper viscosity to flow well through pipes and burners. Many precautions must be observed in the use of fuel oils for domestic and factory purposes. Use of well-placed refractory linings in the combustion chamber is important both to prevent the adjacent parts of the boiler from being overheated and to increase the efficiency of the flame. Radiant heat from the flame is reflected by the refractory lining again to the center of the oil flame to intensify the heat and to provide a more rapid gasifying of the oil vapor. The result is a better combustion and a quiet flame. There are many examples of highly automatic operation of heating systems. Some of these with their safety devices are described. E.P.R.

Converting volumetric to gravimetric analysis for use in comparison of natural gas boiler fuels. PALMER B. PLACE. *Power Plant Eng.*, **35** [6], 346–47 (1931).—The mol system offers the most convenient method of conversion and requires only a knowledge of established principles. (1) A mol is the molecular weight of any substance. (2) A

mol of any gas under standard conditions of 32°F and 14.7 lb. pressure will occupy 359 cu. ft. (3) Per cent by volume is numerically the same as per cent by mol. (4) Gas volumes are proportional to the absolute temperature and inversely proportional to the absolute pressure. Expressing the volume in cubic feet, the pressure in pounds per square inch absolute, and the temperature in degrees absolute (460 + degree F), the relationship is fully expressed by the following equation: $P_1V_1T_2 = P_2V_2T_1$ or (14.7) (359) ÷ 492 = $P_2V_2 \div T_2 = 10.726$. The volume occupied by a molecular weight in pounds of a gas is called the molecular volume. (5) The density of a gas is the weight per cubic foot at a given temperature and pressure. Because of the present popularity of natural gas fuel, several typical samples of different composition have been chosen for comparison and a method of calculation has been developed for this type of fuel.

E.P.R.

Combustion characteristics and calculations for theoretical air requirements of natural gas fuels. PALMER B. PLACE. *Power Plant Eng.*, **35** [10], 545–47 (1931).—Calculations of the amount of air required for combustion, the amount of wet and dry gases formed, and the per cent of carbon dioxide and oxygen in the gases are readily made from the analysis of the fuel gas. These may be plotted in a single chart for any given gas. The charts are described. E.P.R.

Specific heat of waste gases and theoretical flame temperatures. PALMER B. PLACE. *Power Plant Eng.*, **35** [13], 699–701 (1931).—Specific heat of a gas varies with the composition of the gas, with the amount of water vapor present, and with the temperature. The mean specific heat of the wet gases may readily be calculated by simple proportion. For higher temperature ranges and for calculating theoretical flame temperatures, it is desirable to determine the specific heat for each case in question. The specific heats for the usual constituents of furnace gases, *i.e.*, water vapor, carbon dioxide, nitrogen, and oxygen have been established, and it is only necessary to know the analysis of a waste gas to calculate its mean specific heat at any desired temperature. The theoretical flame temperature is the temperature that would result if all of the available heat were used to increase the sensible heat of the wet products of combustion. The available heat is the sum of the net or available heat of combustion of the fuel and the sensible heat in the fuel and in the air used for its combustion. Mathematically the theoretical flame temperature is expressed as follows: $T = \frac{H+(1+A)\,(0.24)\,(t)}{(C_p)\,(W)}$, where T is the theoretical flame temperature in degree F, H is the low or net heat value of the fuel, A is the pound of air per pound of fuel used for combustion, t is the temperature of the fuel and air in degree F, C_p is the mean specific heat of the wet products of combustion from 0 to T degree F, and W is the pound of wet products of combustion per pound of fuel. Resolve the equation to $T \times C_p = \frac{H + (1 + A)\,(0.24)\,(t)}{W}$ and solve for $T \times C_p$.

E.P.R.

Using waste heat in ceramic kilns. N. N. RUDNEV. *Ceramics & Glass*, **7** [7–8], 19–28 (1931).—The amount of heat lost in Russian single chamber kilns could be greatly lowered if measures similar to those taken by several German porcelain manufacturers, and which are given, were taken. M.V.K.

Résumé of theoretical studies and actual tests as affecting design of pulverized coal furnaces, mills, and boilers. E. H. TENNEY. *Power Plant Eng.*, **35** [5], 298–99 (1931).—The size of the coal particles affects nearly every phase of pulverized-fuel firing. The burning process is effected in two steps: (1) the heating and ignition of the dust cloud and (2) the subsequent combustion of the dust particles. The rate at which the dust cloud becomes heated to the ignition point depends upon (1) temperature of ignition

source, (2) temperature at which the air and particles are preheated, (3) thermal capacity of the dust cloud, (4) rate at which heat is conducted to the interior of the particles, and (5) opacity of the dust cloud. The rate of oxygen reaction is dependent upon (1) specific surface of the dust, (2) proportion of air mixed with the dust and the manner in which it is supplied, (3) temperature of combustion space which also determines the rate of chemical reaction between the fuel and air, and (4) relative motion between the dust and the air. E.P.R.

Flue-gas analyses reveal furnace operation. RICHARD BROWN. *Power Plant Eng.*, **35** [16], 843–45 (1931).—Commercial fuels in most cases are composed principally of hydrogen and carbon. Notable exceptions are blast-furnace and producer gases which contain high percentages of nitrogen and carbon dioxide and accordingly do not permit the following analysis. Fuels which lend themselves to this analysis are carbon, coke, coal, oil, natural gas, and hydrogen. When the ultimate analysis of a fuel is known the hydrogen-carbon ratio R may be obtained from the relation $R = (H - O/8) \div C$, where H, O, and C are percentages of hydrogen, oxygen, and carbon. Assuming that any fuel under consideration is composed entirely of hydrogen and carbon and that air is 20.9% O_2 and 79.1% N_2 by volume, the following formulas may be derived: Let C = pound of carbon per pound of fuel, H = pound of hydrogen per pound of fuel, then (1) $R = H \div C$, (2) $C = 1 \div (1 + R)$, (3) $H = R \div (1 + R)$, (4) B.t.u. = $(14{,}600 + 62{,}000R) \div (1 + R)$ B.t.u. per pound of fuel, (5) $W_a = 11.52\,(1 + 3R)\,(1 + A_s) \div (1.46 + 6.2R)$ = pounds of air used per 10,000 B.t.u., and (6) $W_g = (1 + R + 11.52\,(1 + 3R)\,(1 + A_s)) \div (1.46 + 6.2R)$ = pounds of gas per 10,000 B.t.u. E.P.R.

Measuring ash content of flue gases. ANON. *Power Plant Eng.*, **35** [8], 450 (1931).—The growing utilization of pulverized coal makes necessary some method of determining the amount of solids carried by the flue gas or for sampling pulverized coal lines to the burner. Details of equipment and methods for sampling and obtaining data are given. E.P.R.

Progress report on reduction of firing losses by the Union of Makers of Limoges Porcelain. A. CARLES. *Céramique*, **34** [521], 191–99 (1931).—The technical service of the Union was created in 1928 to improve the manufacture of porcelain. All its efforts have been devoted to a study of firing. While shorter firing times are used in Czechoslovakia and Germany, they do not fire as high as they do at Limoges where 1400°C is needed to produce the famous hard porcelain. The principal object was to reduce the spoilage in firing, but actually, shorter firing schedules and less fuel consumption were also obtained. The first step was to equip the kilns with instruments which automatically recorded the temperature and atmosphere at many points in the kilns. Study showed that the kilns could be made more sensitive, the firing time could be halved, fuel saved, "smoking" of ware prevented, and kiln losses greatly reduced. The principal defects encountered have been pitting of the glaze (grésil) and smoking. Pitting was due to the formation of small bubbles in the glaze after fusion had rendered it impermeable. At higher temperatures the bubbles break, forming a pitted surface. A sufficiently high temperature causes the pits to disappear. The "smoking" is an opacity or brown coloration extending through the body. It is found mostly in the hot parts of the kiln. By obtaining sufficient temperature uniformity, both defects could be avoided. C. discusses their causes in detail. By running some fire boxes under oxidizing conditions and some under reducing conditions, heat was generated at the center of the kiln where the flue gases mixed, thus equalizing the temperature. A.E.R.W.

Fuel consumption and costs in a kiln installation in dependence on the kind of kiln used, condition and manner of operating, waste heat, and fuel selection. W. LEDER. *Deut. Ziegel-Ztg.*, No. 30, pp. 395–97; No. 31, pp. 408–11 (1931); *Feuerfest*, **7** [9], 143 (1931).—The numerical influence of the following factors on the consumption of fuel is

discussed: (1) the water content of the charged ware, (2) the relation of a cross-section of the kiln to the volume, (3) the weights in nests per cubic meter of the firing channel, (4) loss of heat of the surface of the firing channel, and (5) the manner of feeding. See also *Ceram. Abs.*, **11** [1], 51 (1932). M.V.K.

Rational management of fuel. E. BARK. *Keramos*, **10** [22-23], 581-85 (1931).—The values of different kinds of fuel are discussed. Data on German coals are given. M.V.K.

BOOKS

New Heat Sources. Economic Heating in the Near Future. (Nuove fonti di calore. Il riscaldamento economico nell imminenta futuro.) L. VALERIO. Bocaa, Torino. 217 pp. Lire 16.00. Reviewed in *Ind. Silicati*, **9** [9], 24 (1931).—The need of reducing the heat loss in low-temperature kilns and furnaces led V. to design a furnace with a counter-current heat recuperator of a new and greatly improved construction. The ideas are theoretically sound but are not sufficiently substantiated by practical data. M.V.K.

Laboratory Manual of Gas, Oil, and Fuel Analysis. CARL J. ENGELDER. John Wiley and Sons, Inc., New York, 1931. 236 pp. Reviewed in *Chem. Met. Eng.*, **38** [10], 598 (1931).—Thirty-four experiments are outlined on testing gas, oil, and solid fuel materials. Some mention of prominent publications in the general field is noted for each main division of the subject matter. The appendix contains useful tables. G.R.S.

Jigging, classification, tabling, and flotation tests of coals presenting difficult washing problems, with particular reference to coals from Pierce County, Wash. B. M. BIRD AND S. M. MARSHALL. Bur. Mines, *Bull.*, No. 337. 132 pp. 35¢. The investigation is described and the most important results are summarized. Detailed data of best washing tests by each process are given and a hindered settling classifier developed during this study is described. New systems of riffling coal-washing tables are discussed as well as a method for adjusting coal-washing tables based upon distribution of the products. R.A.H.

PATENTS

Electric-resistance furnace. WILLIAM JAMES MILLAR. U. S. 1,832,872, Nov. 24, 1931. In an electric furnace heated by nonmetallic resistor elements, a recess formed in the brickwork at each end of the resistors, a metallic casing enclosing the brickwork and provided with holes for the admission of atmospheric air into direct contact with the ends of the resistors, and a substantially vertical passage between the brickwork and casing for conveying the current of air produced by convection.

Electric furnace. RAYMOND C. BENNER AND GEORGE J. EASTER. U. S. 1,837,178, Dec. 15, 1931. In an electrical-resistance furnace, a silicon carbide resistor, an adjacent muffle whose walls are composed of silicon carbide, and means for maintaining a non-oxidizing atmosphere around the resistor and muffle.

Operation of silicon carbide resistors in protective atmospheres. RAYMOND C. BENNER AND GEORGE J. EASTER. U. S. 1,837,179, Dec. 15, 1931. In an electric furnace, a chamber for ware to be treated, silicon carbide resistors within the chamber, the walls of the chamber being composed of a refractory which is permeable to gases, and a granular carbon packing around the chamber walls.

Separating dust from waste gases of furnaces or kilns. A. ANDREAS. Brit. 360,547, Nov. 18, 1931.

Geology

Pneumatolytic synthesis of silicates. II. C. J. Van Nieuwenburg and H. B. Blumendal. *Rec. trav. chim.*, **50** [9–10], 989–97(1931).—The authors continued their researches and prepared an orthosilicate of cadmium. The cadmium oxide was prepared by precipitating a cadmium sulphate solution with NaOH, filtering, washing, and calcining at 700 to 800°C. The products of reaction were small, transparent, colorless crystals of an irregular shape. The chemical analysis showed 19.1% SiO_2 and 78.6% CdO but no traces of water. This product is evidently cadmium orthosilicate, Cd_2SiO_4. It must be noted that cadmium behaves like Zn and Mn in forming an orthosilicate. Alkali aluminum silicates, leucite, orthoclase, analcite, and albite were also prepared. It was found that a pronounced dissimilarity exists between the behavior of the potassium and the sodium aluminum silicates. While the first form orthoclase with the anhydrous leucite as a transition stage, the latter form hydrous silicates, *i.e.*, analcite. This is in accordance with geological evidence where leucite and analcite are found as equivalent constituents of intermediate rocks. Tests with CO_2 showed that it can prevent the formation of silicates (wollastonite). Tests with MoO_3 and WO_3 showed that they are easily soluble in supercritical steam. This fact can explain why molybdates and tungstates generally occur in acid igneous rocks which were formed, in many cases, by gaseous SiO_2–H_2O emanations from a magma. TiO_2 and SnO_2 were not soluble in steam. For Part I see *Ceram. Abs.*, **10** [8], 597 (1931). M.V.K.

System water–silicon. I. A. Smits. *Rec. trav. chim.*, **49**, 962–66 (1930); *Sprechsaal*, **64** [48], 892 (1931).—S. discusses the volatility of silicic acid by steam (see article by Van Nieuwenburg and Blumendal, *Ceram. Abs.*, **10** [2], 152; [10], 735 (1931)) and assumes that the system water–silicon dioxide is the same type as the system ether–anthrachinon, and that in the first system complications appear conditioned by the modification changes of SiO_2. M.V.K.

Titanium silicate "murmanite." N. N. Gutkova. *Compt. rend. acad. sci.* [U.S.S.R.], No. 27, 731–37 (1930).—G. describes "murmanite," a mineral found in pegmatite formations in Luanrust, and discusses its physical properties, chemical analysis, crystallographic character, and optical properties. M.V.K.

Diatomite. V. L. Eardley-Wilmot. *Can. Mining Met. Bull.*, No. 229, 638–58 (1931); *Chim. & ind.*, **26** [4], 878–79 (1931).—Diatomite is used in the form of a white, porous, inert powder. It is composed of the siliceous remains of myriads of diatom plants of the alga type. Numerous types of diatoms are known, but only two principal types of diatomite, *viz.*, those coming from the sea bottom and those formed in fresh water. Diatomite is a hydrated silica. Some pure forms contain 96% silica and 4% water, but generally different impurities, *e.g.*, iron, alumina, magnesia, lime, and carbonates are present. Its structure and physical properties, some of which can be ascertained by the microscope, determine its use. It is used mostly for sound and calorific insulators (because of its porosity and low conductivity), filtering material, constituent of concrete, for polishing metals, and for catalyzers. Canada has enormous deposits of this product in Nova Scotia, Ontario, and British Columbia, but the U.S., Germany, and North Africa produce most of it. The treatment of the raw material is simple. It is heated to redness to 800° and pulverized. See also *Ceram. Abs.*, **9** [8], 674 (1930). M.V.K.

Bentonite and its use. Anon. *Chem. Trade Jour.*, **88** [2299], 594 (1931).—The two most important uses for bentonite are for oil refining and foundry work. For oil refining, bentonites of the mountain type, mined principally in Calif., are used almost exclusively. The clay treated before use with sulphuric acid gives the best results and is superior to fuller's earth, but untreated clay is also used. Bentonite has found increas-

ing application in the foundry industry. Its principal functions are as a bonding ingredient to increase the strength of molding and core sands and as a suspending agent in core and mold washes. Bentonite is also used in the cement, mortar, and concrete industry where it improves the workability and flow of concrete, in preventing segregation before the set, and in making the finished product waterproof. M.V.K.

Graphite. M. R. CORDEBAS. *Mines, Carrières, Grandes Enterprises*, December, 1929; *Ind. chim.*, **17** [197], 407 (1930).—There are different mineralogical varieties of graphite: (1) the "lump" form in the shape of a kidney, (2) the "flake" form, made up of small spangles, and (3) "amorphous" form which has excessively thin crystals. The flake variety is found on the island of Madagascar, Indo-China, Bavaria, and Canada, the lump form is found in Ceylon and Siberia, and the amorphous form in France, Germany, Mexico, and Italy. Graphite is refined electrically or chemically. It is used principally in the manufacture of refractory crucibles, electrodes, galvanoplastics, etc. M.V.K.

Fluorspar. I. ANON. *Jour. ind.*, **9**, 6 (1930); *Emaillewaren-Ind.*, **8** [31], 39 (1931).—The French deposits of fluorspar contain almost pure fluorine (86 to 97%); the largest deposits are in the Auvergne and the Morvan. Fluorspar is characterized by a low fusing point between 1250 and 1400°C and is extensively used in metallurgy. The ceramic industry uses fluorspar in large quantities, particularly for manufacturing stoneware, opaque glass, and enamels. A kind of porcelain without silica having a pure fluorine base is also obtained from it. It is extensively used for lowering the sintering point of Portland cement. In chemistry, fluohydric acid is used for engraving or cutting glass, in the production of rough or matted glass, and for obtaining fluosilicates. M.V.K.

Production of borax and potash. ANON. *Chem. Met. Eng.*, **38** [11], 645 (1931).—A brief outline is given of the expansion of the plant of the American Potash and Chemical Corp., at Trona, Calif. Illustrated. G.R.S.

Mining potash in America. ANON. *Chem. Met. Eng.*, **38** [11], 666 (1931).—At Carlsbad, N. M., the ore is mined from the 1000-ft. level, hoisted to the surface, ground, screened, and loaded on cars. G.R.S.

Feldspar and its uses. F. P. KNIGHT. *Ceram. Ind.*, **17** [6], 453–55 (1931).—The preparation of feldspar for the market includes a series of specialized operations starting from the mines and on through various processes into the various storage bins. The analyzed contents of these bins cover a wide range of feldspar composition and it is with skill and utmost care that the commercial product known as feldspar is produced and controlled for a number of uses. K. discusses this production and the function of feldspar in white ware, enamelware, glass, and abrasives. W.W.M.

Crystal structure of feldspars. E. SCHIEBOLD. *Fortschritte Mineral., Kryst. Petrog.*, **14**, 62–68 (1929). (*C.A.*)

Persistence of feldspar in beach sand. J. H. C. MARTENS. *Amer. Mineralogist*, **16** [11], 526–31 (1931).—The decrease in the ratio of feldspar to quartz with increasing distance from the source of the sand is clearly shown by microscopic analyses of sands collected over an interval of more than 500 miles along the beach on the Atlantic coast of the southeastern states. G.R.S.

Diatoms of California. M. L. HARTMANN. *Chem. Met. Eng.*, **38** [11], 652 (1931).—A general description of diatoms is followed by an outline of the deposits in southern Calif. at Lompoc. The method of cutting "natural" insulating brick and their properties are given. Lightness, high porosity, chemical inactivity, and infusibility are the basis of the usefulness of diatomite in heat insulation. A furnace-insulating brick is made by coarsely crushing some of the wet material slightly contaminated with clay, remolding to brick shapes, and firing in a tunnel kiln. Sometimes such brick are light-

ened by mixing with some organic filler such as cork or sawdust which is burned out in the firing leaving cavities. Methods of grinding, drying, and collecting the powder are given. G.R.S.

Different varieties of clay. V. CHARRIN. *Rev. gén. mat. plastiques*, **7**, 205–209 (1931). (*C.A.*)

Properties of refined kaolins. A. A. SCHMELEV AND D. I. SMIRNOV. *Ceramics & Glass*, **7** [7–8], 36–41 (1931).—The authors emphasize the necessity of exact control in refining kaolin. Kaolin refined with electrolytes differs from that refined chemically as the latter produces other properties that may cause defects in the mass and slip. Liquid glass used as electrolyte for kaolin lowers its temperature of sintering (action of Na_2O and SiO_2). Comparative data for kaolins refined by chemical means and without electrolytes are given. M.V.K.

Soda from alkaline lake brines. W. HIRSCHKIND. *Chem. Met. Eng.*, **38** [11], 657 (1931).—A brief statement is given of the salts found in various lakes in Calif. and adjacent states. Special attention is given to Owens and Searles lakes. G.R.S.

Report on high-quality kaolin in North Carolina. ANON. *Ashville* (N. C.) *Citizen; Rock Prod.*, **34** [23], 61 (1931).—W. F. Prouty of the geology department of the Univ. of N. C. states that recently prospected areas near Spruce Pine, N. C., have yielded a grade of kaolin superior to the best English china clay. The origin is the weathering of masses of injected pegmatite which is still going on. W.W.M.

Nonmetallic mining in North Carolina. R. CARL MOORE. *Mfrs. Rec.*, **100** [20], 31–32 (1931).—The chief mining operations of this region, centering around Spruce Pine, are the production of feldspar, mica, and kaolin. N. C. leads in the production of feldspar and in the production and refining of kaolin. E.P.R.

Nonmetallic-mineral resources and their development in Florida. HERMAN GUNTER. *Pit & Quarry*, **23** [5], 31–36 (1931). E.P.R.

Geophysics. ANON. *Engineer*, **152**, 112–14, 140–42 (1931).—A series of articles is presented on the new method of prospecting, for the adequate supply of experts for which a chair of Geophysics has been established at the Imperial College, London. H.H.S.

BOOK AND BULLETINS

The Soil and the Microbe. SELMAN A. WAKSMAN AND ROBERT L. STARKEY. John Wiley and Sons, Inc., New York, 1931. xi + 260 pp. Reviewed in *Soil Sci.*, **32** [5], 406 (1931).—The transformation of mineral substances in the soil through direct or indirect action of microörganisms is described. G.R.S.

Silica in 1930. E. R. PHILLIPS. Bur. Mines, *Mineral Resources U. S.*, 6 pp. 5¢. Data are given on production, consumption, exports, and imports. R.A.H.

Microscopic Determination of the Ore Minerals. M. N. SHORT. Reviewed in *Amer. Mineralogist*, **16** [11], 555–56 (1931); for abstract see *Ceram. Abs.*, **10** [10], 730 (1931). G.R.S.

Chemistry and Physics

Various methods of studying crystal structure by X-ray analysis. A. W. KRAMER. *Power Plant Eng.*, **35** [5], 301–303 (1931).—Radiation proceeding from an ordinary X-ray tube does not consist of waves of a single frequency but of waves of various frequencies. Radiation may be compared to "white light." The line spectra or single frequencies superimposed upon the general radiation serve to identify the element out of which the target in the X-ray tube is made. For every element there are characteristic groups of wave-lengths. These groups are called the K, L, M, and N series and represent the energy levels of the electrons in the atom. In the Laue method the effect of the

entire general radiation is utilized, in the powder method only one of the characteristic wave-lengths is employed, and in another only the limiting (the shortest) wave-length is used. In the Laue method, when the crystal is placed in the path of "white" X-rays it will, in general, diffract some of the X-rays, for no matter what plane of atoms in the crystal may be inclined to the beam, there will be some wave-lengths present which will require the exact grazing angle of incidence for diffraction from that family of planes, *i.e.*, for any value of d and Θ in the equation, $mL = 2d \sin \Theta$. Another method using monochromatic X-rays is the so-called "powder" method developed independently by Hull, Debye, and Scherrer. This method was largely devised to investigate materials not obtainable in crystals large enough for the Laue or Bragg methods. It utilizes crystals which have been crushed to such a fine powder that the fragments have random or chaotic orientation. The three methods of crystal analysis together with the type of photograph produced by each method are shown. See also *Ceram. Abs.*, 9 [10], 882 (1930). E.P.R.

Significance of Moseley's critical investigations on X-ray spectra of the elements. A. W. KRAMER. *Power Plant Eng.*, **35** [7], 411–13 (1931).—Moseley photographed the X-ray spectra of as many elements as his facilities permitted and in all cases he found there was a definite relation between successive elements in the periodic table which was proportional to the square feet of the frequency. He also found that all the elements could be arranged in the order of their frequency relations beginning with hydrogen as one and ending with uranium as 92. When the elements are arranged in the order of their characteristic X-ray frequencies, each one is obtainable from its predecessor by simple addition. Moseley's investigations and the researches of others that followed may be considered the first definite proof that the nucleus of the atom is composed of grains of positive electricity protons. E.P.R.

Knowledge of silica and silicates. F. W. MEIER AND LUDWIG SCHUSTER. *Zement*, **20** [23], 538–40 (1931).—The authors give the following method: The residue obtained in the usual way, after being decomposed with hydrochloric acid, is digested with the filter in a platinum dish over a boiling water bath with 100 (50) cc. of 5% Na_2CO_3 solution. The filtered hot residue is digested together with the filter for $^1/_4$ hour with 100 (50) cc. 10% hydrochloric acid, washed with dilute HCl and hot water, dried, heated to redness, and weighed. M.V.K.

Determining alkalis. WALTER MARSCHNER. *Zement*, **20** [20], 466 (1931).—A new simple method for determining alkalis in cement is described. Two grams of cement are decomposed by dilute hydrochloric acid and the silica is converted in an insoluble form. The dry residue is dissolved with water, slightly acidified with HCl, and the sulphuric acid precipitated with a small surplus of barium chloride; it is then evaporated to dryness. The residue is dissolved with hot water and treated with caustic baryta free from alkalis until the phenolphthalein reddens. It is evaporated to dryness, dissolved in hot water, filtered, and washed with hot water. The hot filtrate is precipitated with ammonia and ammonium carbonate and left to stand hot for $^1/_2$ hr. After filtering, it is washed in hot water containing ammoniac and ammonium carbonate. The filtrate is dried and the ammonium salts expelled by gentle heating to redness. It is dissolved with water, treated again with ammoniac and ammonium carbonate, and filtered after a short heating. The filtrate is dried and again treated as before. It is dissolved with water, some ammoniac and ammonium carbonate are added, and filtered into a platinum bowl. After evaporating to dryness, the residue is evaporated with dilute HCl, mildly calcined over a flame, and weighed. The amounts of potassium chloride and sodium chloride are obtained and the potassium can be determined according to the perchlorate method. Cement may also be decomposed by sulphuric acid or hydrofluoric acid instead of HCl, and is treated as above. M.V.K.

Determining alkalis according to the Lawrence Smith method. G. PRUESSING. *Chim. & ind.*, **26** [4], 863 (1931); for abstract see *Ceram. Abs.*, **10** [8], 607 (1931). M.V.K.

Manufacture of sodium fluoride. N. SAJINE. *Zhur. Khim. Prom.*, **7**, 2003–2113 (1930); *Chem. Trade Jour.*, **89** [2312], 245 (1931).—The reaction employed consists essentially in the fusion of a mixture of fluorspar, sodium carbonate, and silica in special furnaces with the subsequent extraction of the sodium fluoride formed. The reactions which take place are shown in the following equations: (1) $2CaF_2 + 2Na_2CO_3 + SiO_2 = 2CaO{\cdot}SiO_2 + 4NaF + 2CO_2$ and (2) $CaF_2 + Na_2CO_3 + SiO_2 = CaO{\cdot}SiO_2 + 2NaF + CO_2$. The sodium fluoride is easily extracted from the melt by washing with hot water and on concentrating, a very pure product is obtained. The main advantage of this process is the entire absence of the emission of harmful gases, and as a reaction occurs in alkaline medium, no fluosilicic acid is formed. The process is simple, only one fusion being required. The silica content of the fluorspar used does not detract from its utilization in this process. The disadvantages are (1) the necessity for evaporating the 30% solution of sodium fluoride obtained by lixiviation and (2) the fact that the yield obtained does not exceed 60% of the theoretical. M.V.K.

Determining fluorine as calcium fluoride. E. CARRIÈRE AND ROUANET. *Chim. & ind.*, **24** [1], 41 (1930); for abstract see *Ceram. Abs.*, **10** [7], 525 (1931). M.V.K.

Detergent value of sodium metasilicate. C. L. BAKER. *Ind. Eng. Chem.*, **23**, 1025–32 (1931).—The detergent properties of Na_2SiO_3 have been compared with those of NaOH, Na_2CO_3, and Na_3PO_4 in respect to wetting, emulsification, deflocculation, and dissolving power. Na_2SiO_3 is more effective in wetting glass or in displacing petroleum from a glass surface than are the other reagents examined. Solutions of $Na_2SiO_3{\cdot}5H_2O$ and $Na_3PO_4{\cdot}12H_2O$ emulsify a light motor oil better than do those of Na_2CO_3 and NaOH, and the deflocculating power of $Na_2SiO_3{\cdot}5H_2O$ for bone black is equal to that of the other reagents. Na_2SiO_3 yields solutions of higher p_H than do the other alkalis, with the exception of NaOH, and a larger proportion of the Na_2O is available at a p_H effective in dissolving fats than in any other alkali salt considered. Solutions of $Na_2SiO_3{\cdot}5H_2O$ can be used for washing tin-plated articles which would be attacked by the other reagents. The foaming power of a soap solution is related to its power to suspend solid dirt. Solutions of $Na_2SiO_3{\cdot}5H_2O$ give a larger volume of foam with Na stearate at 60° than the other alkalis at all concentrations, excepting a very small concentration range where NaOH is superior. A smaller amount of soap is required to wash clothes when the p_H is maintained above 10.5. See also *Ceram. Abs.*, **10** [7], 483 (1931). (*B.C.A.*)

Laws of colloidal behavior. VI. Amphoteric behavior. SANTE MATTSON. *Soil Sci.*, **32** [5], 343–65 (1931).—Soil colloids in which the ratio of silica (or other acid groups) to sesquioxides is low show a pronounced amphoteric behavior. When this ratio is high the materials do not react amphoterically with the neutral salt anions and cations within the usual p_H range of soils. All colloids react amphoterically with the phosphates. The isoelectric point is not a fixed point but varies with the dissociation of compounds which the colloid complex forms with the adsorbed ions. The fact that the soil colloids react as acids above a certain p_H and as bases below this p_H leads to the development of an exchange alkalinity in the second case. The transition point between the two forms of reaction is termed the point of exchange neutrality. Here the anion and cation adsorptions balance each other. The point of exchange neutrality is not a fixed point but is governed by the energy of displacement of the anions and cations which displace the OH and H ions in the electrodialized free ampholytoid. Its relation to the isoelectric point is discussed. Various types of amphoteric colloids are discussed. The activity concept is applied to the acidoid/basoid ratio of soil colloids. For Part V see *Ceram. Abs.*, **10** [8], 600 (1931). G.R.S.

Physical, chemical, and technical properties of clays. I. Physical properties. Plasticity. P. A. ZEMIATCHENSKY. *U.S.S.R. Sci.-Tech. Dept. Supreme Council Nat. Econ.*, No. 213; *Chem. Zentr.*, **II**, 2174 (1930); see also *Ceram. Abs.*, **8** [11], 847 (1929). (*C.A.*)

Quantitative electrokinetical colloid determination (with especial reference to clay determination in soils). ADOLF REIFENBERG. *Z. Pflanzenernähr., Düngung Bodenk.*, **21***A*, 138–60 (1931).—A somewhat changed cataphoresis apparatus of Michaelis is used to determine the colloidal content of soils, kaolin, finely ground phosphates, etc. The method depends primarily on the principle that for a given mass of a colloidal suspension, a more or less definite quantity will migrate within a given time with a given potential and other set conditions. The quantity which migrates within a given time may be collected and properly determined by weighing or by other means, a factor being used for specific materials to determine the total quantity of particles of colloidal dimensions (more or less definitely limited particle sizes) from the quantity which migrated in a set time. For soils carefully dispersed by washing, digestion, and the addition of 0.002 *N* NaOH, comparable results with those of ordinary mechanical analyses (such as that of Atterberg) were obtained. (*C.A.*)

Determination of the total surface area of soils, clays, etc. H. KURON. *Z. Pflanzenernähr., Düngung Bodenk.*, **18***A*, 179–203 (1930).—The adsorption of water by soils, their mechanical fractions, sand, and permutite are examined. At lower vapor pressures adsorption follows the Ostwald-Freundlich rule in all cases and calculations of total surface area of the materials can be made directly. The point of inflection of drying-out curves of soil and its constituent fractions occurs at the same vapor pressure. The water adsorption of a soil at various vapor pressures can be represented as the sum of the adsorptive values of its constituent fractions. Drying-out curves for permutite are similar to those of natural zeolites. See following abstract. (*C.A.*)

Determination of the total surface area of soils, clays, etc. III. Influence of salt content on the water combination in soils and clays. H. KURON. *Z. Pflanzenernähr., Düngung Bodenk.*, **21***A*, 271–300 (1931).—The water combination in a Na clay and a Ca clay with the addition of NaCl or Na_2CO_3 in proportions ranging from 1 to 5% was investigated. Not only capillary water but also adsorbed water is capable of dissolving salts. The solubility is obviously not changed. In a system, Na clay + NaCl + water, all the combined water does not act as a solution medium until the NaCl concentration is very high. In a system, Na clay + Na_2CO_3 + water, a positive adsorption of NaOH by the clay occurs. The addition of a Na salt is without influence on the adsorption isotherm of a Na clay as determined by the specific boundary surface properties of the solid phase. In the systems, Ca clay + NaCl + water and Ca clay + Na_2CO_3 + water, the exchange reaction is active as well as the adsorption. Changes of water combination to be explained by the influence of the addition of salts on the capillary structure of clay could not be determined in this investigation. The variations of the water-combining capacity of clays (and soils) which have been saturated with Ca, Mg, and H change in such a way with the addition of soda that it appears possible to determine indirectly the adsorption capacities of these clays and soils. This possibility is of particular significance for carbonate-containing soils. (*C.A.*)

Fundamentals and economies in the clay industries. X. ELLIS LOVEJOY. *Clay-Worker*, **96** [5], 287–90 (1931).—The various minerals in clay are enumerated and discussed from the standpoint of their particular properties and the effect each has on the properties of the fired clay. The classification of the different clays according to their mineral content is taken up. Eutectics, eutectic point or state, or eutectoids constitute an important and interesting phenomenon in the bonding of clayware by fusion of the component minerals. The pyrochemical changes which occur in the clays with forma-

tion of eutectics, etc., are discussed. The phenomenon of freezing, believed to be due to the development of crystals in a noneutectic mass, and crystallizations in fusions are discussed. For Part IX see *Ceram. Abs.*, **11** [1], 65 (1932). E.J.V.

Determining free lime. K. SCHINDLER. *Zement*, **20** [17], 389–90 (1931).—Several drops of glycerin are titrated with 0.05 g. calcium oxide to a complete homogeneity. Some more glycerin is added and the mixture is put into an Erlenmeyer flask. A total quantity of 10 cc. glycerin is sufficient. The flask is put in a heated water bath for 5 min. The turbid suspension of lime particles is almost immediately cleared to a transparent liquid which does not contain any solid particles. After a certain length of time, 20 cc. of absolute methyl alcohol are added with several drops of a 2% phenolphthalein solution and heated to the beginning of boiling; it is titrated up to the moment when the red color of the liquid begins to be lighter. After this, it is titrated drop by drop until the color disappears completely. The determination of free lime in cement and other materials is given. M.V.K.

Value of titrometric methods in determining the constituents of basic reaction of slaked lime and quicklime. F. MACH AND R. HERMANN. *Z. anal. Chem.*, **84** [1–2], 1–14 (1931); *Chim. & ind.*, **26** [4], 863 (1931).—The analytical methods for determining the value of basic compounds of limestone are numerous and the authors tested all of them in order to find the most suitable. Lime silicates were also treated with hydrochloric acid solutions of different concentrations. The methods using oxalic acid, saccharose, and glycerin and others were tested. It was found that silicates of lime and magnesium whose compositions are varied are decomposed unequally. Some of them are affected by weak organic acids, solutions of saccharose, or glycerin, while others are not attacked even by concentrated hydrochloric acid. All tests to separate the oxides, carbonates, and silicates to determine them titrometrically were negative; the silicates always behave indeterminately. Only the treatment with hydrochloric acid gives satisfactory results. M.V.K.

Specific test for zirconium. F. FEIGL, P. KRUMHOLZ, AND E. RAJMANN. *Mikrochemie*, **9**, 395–400 (1931); *Analyst*, **56**, 615–16 (1931).—Zr is tested for microchemically with paradimethylaminoazophenylarsenic acid. Ta is the only metal which interferes. H.H.S.

Rapid determination of lead in small quantities in calcium phosphate (bone ash). J. R. NICHOLLS. *Analyst*, **56**, 594–95 (1931).—Pb in biological specimens may be determined by dissolving the sample in HCl, adding ammonium citrate, KCN, and Na_2S, and estimating colorimetrically against a standard solution. H.H.S.

Use of zinc oxide in determinations of cobalt and manganese. J. I. HOFFMAN. Bur. Stand., *Jour. Research*, **7** [5], 883–87 (1931); R.P. 380.—H. presents data on the behavior of the constituents of steel in precipitations by zinc oxide and gives directions for the determination of cobalt. The use of precipitations with zinc oxide in determinations of manganese and nickel and the purity of the zinc oxide reagent are also discussed. R.A.H.

New method of separating lithium from potassium and sodium with dioxane. A. SINKA. *Z. anal. Chem.*, **80**, 430–35 (1930); *Sprechsaal*, **64** [48], 892 (1931).—By extracting alkali metal chlorides, KCl, NaCl, and LiCl with boiling pure dioxane, LiCl is quantitatively dissolved while both the other chlorides remain insoluble. The purification of dioxane (diethylen dioxide) and the extraction process is described. The lithium extract from the chloride mixtures was found to be absolutely free from Na traces. M.V.K.

Sorption of gas by minerals. II. Laumontite. JITSUSABURO SAMEISHIMA. *Bull. Chem. Soc.* [Japan], **5**, 303–10 (1930).—Laumontite ($CaAl_2Si_4O_{12}\cdot 4H_2O$) sorbs NH_3 but not CO_2. The sorption data are tabulated and presented in curves. The dryness of the

mineral has an important influence. NH_3 combines chemically with the dehydrated mineral. **III. Silicic acid minerals.** *Ibid.*, **6**, 165–73 (1931).—The sorption of NH_3 by dehydrated chalcedony, opal, diatomite, natural silica gel, and siliceous sinter was measured. All sorb considerable amounts of NH_3 at ordinary temperature: $x = K \log t + k$, where x is the sorption amount at time t. For Part I see *Ceram. Abs.*, **10** [6], 461 (1931). (*C.A.*)

Water content of inorganic compounds. I. Water content of acid clay of Koto. MINORU NAKAMOTO AND GYONEN SANO. *Jour. Chem. Soc.* [Japan], **50**, 473–86 (1929).—From studies on the velocity of water absorption, it is concluded that the composition of white acid clay is $Al_2O_3 \cdot 8SiO_2 \cdot H_2O$. Loss of absorbed water takes place between 20° and 250° and leaves 1 molecule of water which is lost on heating up to 350 to 500°; the clay becomes anhydrous on heating above 600°. The greatest water-absorbing capacity was obtained with clay dehydrated between 80° and 200°. Hydration and dehydration are reversible if the clay is $Al_2O_3 \cdot 8SiO_2 \cdot H_2O$ or its solid solution with more water, but become irreversible when the 1 molecule of combined water is lost. From evidence based on X-ray analyses, it appears that white acid clay has a definite crystalline structure and contains no free Al_2O_3 or SiO_2. (*C.A.*)

Electrolytes in clays. L. M. ZARUDSKIĬ. *Zhur. Prikladnoĭ Khim.*, **4**, 9–33 (1931).—Experiments with electrical conductivity of solutions obtained by extracting clays with distilled water showed that $k = \beta C^{\log D}$ (I), where k = specific conductivity, C = grams of clay extracted with 100 cc. water, β = conductivity at $C = 1$ ("initial conductivity"), and D = coefficient of hysteresis (proportionate decrease in conductivity when the clay-water ratio is increased ten-fold). The change in conductivity through the evaporation of the above extracts is expressed by $k' = \beta' C'^{\log D'}$ (II), where k' = electrical conductivity when the extract is concentrated C' times, and β' and D' = coefficients. II changes to $k_1 = \beta C_1^{\log D_1}$ (III), if the extract is obtained from 1 g. clay/100 g. water, the subscript denoting that the formula applies to extracts evaporated in the absence of clays. The amount of electrolytes adsorbed by clays is characterized by the increase in D and is a measure of the "fatness" of the clay. The law of Stokes should be modified by giving the proper allowance for the hydration of clay particles. (*C.A.*)

Methods of hydrogen-ion estimation. A. J. PARKER AND L. S. SPACKMAN. *N. Z. Jour. Sci. Tech.*, **13**, 48–49 (1931).—The use of $BaSO_4$, as suggested by Baver and Rehling (1930) for flocculating soil colloids before determining p_H colorimetrically, is recommended as giving results comparable to the electrometric method. H.H.S.

BOOKS

The Structure of Crystals. RALPH W. G. WYCKOFF. Amer. Chem. Soc. Monograph Series. 2d ed. Chemical Catalog Co., New York, 1931. 497 pp. Price $7.50. Reviewed in *Can. Chem. Met.*, **15** [11], 46 (1931); *Chem. & Ind.*, **50** [44], 877 (1931).—This edition is largely rewritten to bring it up to date. The first section, dealing with crystal structure methods, is distinguished by clear and lucid treatment, and the diagrams and sketches of apparatus are well done. The second part is devoted to a description of the crystal structures thus far determined with X-rays. A complete bibliography (not including work done in 1931) is included. E.J.V.

Colloids. E. S. HEDGES. vii + 272 pp. E. Arnold and Co., London. Reviewed in *Chem. & Ind.*, **50** [44], 884 (1931).—This book is more than a compilation of modern research; it is a balanced discussion of current ideas on colloids with well chosen illustrative examples. G.R.S.

Colorimetric and Potentiometric Determination of p_H. Outline of Electrometric Titrations. I. M. KOLTHOFF. xi + 167 pp. Chapman and Hall, London, and J. Wiley and Sons, New York. Reviewed in *Chem. & Ind.*, **50** [44], 877 (1931).—K. states

that the book was written with the idea of offering an introduction to the above fields without claiming in any way an exhaustive treatment. The theory and technique of potentiometric methods are dealt with briefly but adequately. The measurement of p_H with hydrogen and quinhydrone electrodes is described in some detail. The discussion of potentiometric titrations includes descriptions of several simplified methods. Numerous references to more exhaustive works will greatly facilitate a more intensive study of any portion of the field. G.R.S.

Alkali and Alkaline Earth Compound Technology. (Alkalien und Erdalkalien; in Ausgewählter Kapiteln.) BRUNO WAESER. Theodor Steinkopff, Berlin, 1931. 200 pp. Unbound 13.50 Rm., bound 15.00 Rm. Reviewed in *Chem. Trade Jour.*, **88** [2301], 645 (1931).—W. discusses systematically sodium carbonate and caustic soda, potassium carbonate and caustic potash, the peroxides, boron compounds, halogen compounds, phosphates and arsenates, sulphur compounds, silicates, etc. A discussion of the calcium and barium compounds follows and the final sections are devoted to strontium and beryllium compounds. M.V.K.

Analysis by Elutriation. Vol. X. (Die Schlammanalyse.) H. GESSNER. Reviewed in *Chem. & Ind.*, **50** [44], 883–84 (1931); *Soil Sci.*, **32** [4], 326 (1931); see also *Ceram. Abs.*, **11** [1], 64 (1932). G.R.S.

Handbook of Chemical Microscopy. Vol. II. E. M. CHAMOT AND C. W. MASON. ix + 411 pp., 187 figs. Chapman & Hall, London, 1931. Price 22s 6d. Reviewed in *Analyst*, **56**, 559–60 (1931); see also *Ceram. Abs.*, **11** [1], 64 (1932). H.H.S.

Volumetric-analytical determination of silicon dioxide in silicates. A. K. BABKO. *Trans. Kiev Div. Ukrainian Sci. Research Inst. Silicate Ind.* [U.S.S.R.], No. 5, 15 pp. (1930).—Fuse the silicate with K_2CO_3, transfer the melt to a platinum dish, dissolve with excess of hydrochloric acid, and add ammonium fluoride to convert the inert silicon dioxide in the complex acid, H_2SiF_6. Filter the precipitate of potassium silicofluoride through a funnel whose walls are covered with paraffin to avoid the dissolving action of HF on the glass funnel. Wash the precipitate with a saturated solution of K_2SiF_6, place the filter with the precipitate in a cone flask, add crystalline $CaCl_2 \cdot 6H_2O$ (to precipitate the F-ion), warm over the water bath, and titrate with sodium hydroxide. The complete coagulation of the precipitate CaF_2 and $Si(OH)_4$ or the change of the color of methyl-red indicates the end-point of titration. The duration of the determination is 3 to $3^1/_2$ hr. The average error is claimed to be 0.3 to 0.4%. To obtain more exact results the content of SiO_2 in the reagents, K_2CO_3 and NH_4F, may be estimated. S.I.P.

Glossary of Technical Terms: German-English-French. BRITISH ALUMINIUM CO. *British Aluminium Co. Intelligence Memo.*, Sept. 4, 1931.—This useful publication gives a long list of technical terms, more particularly in connection with metallurgy. It is based on alphabetical order in regard to the German words, English and French equivalents being given in separate columns. (*B.N.F.M.R.A.*)

Book Review

Plasticity. A. NADAI AND A. M. WAHL. 349 pp. Illustrated. McGraw-Hill Publishing Co., Ltd., 1931. 30s. This volume is the first of a series of monographs to be produced by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. These four societies propose to provide for the production of "selected books adjudged to possess usefulness for engineers and industry and not likely to be published commercially because of too limited sale without special introduction." The present book deals with a subject which has come into great prominence in recent years owing to the modern recognition of the importance of the

study of plastic deformation of materials as a necessary adjunct to the study of elastic deformations. Modern thought tends to the view that perfect elasticity is an ideal state never approached in actual practical materials, especially at elevated temperatures. The author gives a complete description of the present state of the mechanics of the plastic state of metals as developed by recent work of mathematicians and engineers, and supplements the information with numerous diagrams and photographs showing the mode of formation and position of slip lines under the actions of stresses of all characters. He further extends the results of laboratory tests to the consideration of plastic deformations met in rocks and minerals. The translation of the text from the original German has been carried out efficiently by A. M. Wahl.

PATENTS

Purifying sodium silicate solutions. EDWARD A. TAYLOR. U. S. 1,836,093, Dec. 15, 1931. In a process of purifying a sodium silicate solution containing suspended insoluble impurities, the steps of forming a precipitate of an alkaline earth metal salt within the solution and removing the combined insoluble and precipitate from the solution.

Separating sodium salts from mixtures thereof. WILLIAM H. ALLEN, WILLIAM A. GALE, AND CHARLES F. RITCHIE. U. S. 1,836,426, Dec. 15, 1931. A process of treating sodium carbonate-sodium sulphate complexes which comprises bringing the salts to saturation in water at a temperature below the transition point of Glauber salt to anhydrous sodium sulphate, then exceeding the saturation point of the solution, and increasing the percentage of sodium carbonate in the solution while forming a solid phase of Glauber salt.

Producing sodium bicarbonate and sodium sulphate decahydrate from mixtures of sodium sulphate and sodium carbonate. WILLIAM H. ALLEN, WILLIAM A. GALE, AND CHARLES F. RITCHIE. U. S. 1,836,427, Dec. 15, 1931. A process of treating sodium carbonate-sodium sulphate complexes which comprises heating the solution of the complex to a temperature above the transition point of sodium carbonate and sodium sulphate to the double salt burkeite, which solution or complex contains a greater ratio of sodium carbonate to sodium sulphate than the ratio of these salts in burkeite, then adding sodium chloride to the solution in sufficient quantities to depress the solubility of burkeite in the solution, cause the solution to precipitate burkeite, and materially increase the ratio of carbonate to sulphate, and finally carbonating the solution to precipitate sodium bicarbonate.

Wetting-out agent or emulsifier. JAMES BADDILEY AND ERNEST CHAPMAN. U. S. 1,836,428, Dec. 15, 1931. The process of manufacturing a wetting-out agent from mineral-oil fractions boiling between 150 and 300°C which are capable of sulphonation which comprises sulphonating the oil and condensing with an alcohol.

Manufacture or water-soluble sulphonic acids of mineral oils. JAMES BADDILEY AND ERNEST CHAPMAN. U. S. 1,836,429, Dec. 15, 1931. In the manufacture of substances possessing wetting-out properties, the process which comprises sulphonating a sulphur dioxide extract of mineral oil boiling above 260°C and isolating a soluble salt of the product formed thereby, the amount of sulphonating agent used in the process being somewhat greater than that of the sulphur dioxide extract.

Detergent, cleansing, and polishing composition. JAMES BADDILEY AND ERNEST CHAPMAN. U. S. 1,836,430, Dec. 15, 1931. A new tile-cleaning composition for cleansing tile, walls, stoneware, glass, metals, and painted and polished surfaces comprising a sulphonated alkylated mineral-oil fraction and mineral abrasive material.

Wetting-out agent or emulsifier. JAMES BADDILEY AND ERNEST CHAPMAN. U. S. 1,836,431, Dec. 15, 1931. The process of manufacturing a wetting-out agent from

mineral-oil fractions boiling between 150°C and 300°C which comprises sulphonating the oil and condensing with a saturated, monohydroxyalcohol; the process being conducted at temperatures not exceeding 65°C.

Titanium pigments and their manufacture. J. BLUMENFELD. Brit. 360,436, Nov. 18, 1931.

Production of beryllium oxide or beryllium hydroxide. SIEMENS & HALSKE AKT.-GES. Brit. 360,758, Nov. 18, 1931.

Manufacture of sodium silicate. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Brit. 361,823, Dec. 2, 1931.

General

Research in industry. P. DUNSHEATH. *Electrician*, **106** [2758], 543–45 (1931).—No industrial concern can remain in existence or advance without continually augmenting its knowledge of the materials which it uses, its processes, and products. Research takes nothing for granted, is not even satisfied with understanding, and ever insists on questioning with a view to contradicting. In industrial research precision is rarely attainable; therefore before small scale results are applied on a large scale they should be checked over and over again and a measure of their reliability obtained by considering their variation among themselves. Much tact is required of the research man in dealing with the factory staff; he should never look for credit for any achievement. To be able to find the solution of a definite problem requires a greater mental training than to produce an invention more or less by accident. The first step in scientific research is to replace the complicated system of causation in which the problem is normally encountered by others in which only one quantity varies at a time. The data should be prepared in the form of tables or curves and should give the information in the most useful and palatable form for direct use. Research is not design or routine testing; it cannot be confused with consulting or managerial functions, nor is it an advertising department. J.G.T.

Glass and china. G. STOTZ. *Sprechsaal*, **64** [40], 737–38 (1931); see following abstract. W.M.C.

Glass and china. G. E. PAZAUREK. *Sprechsaal*, **64** [41], 758 (1931); for abstract see *Ceram. Abs.*, **10** [12], 868 (1931). W.M.C.

Pioneering in construction field. R. D. PROCTOR. *Glass Ind.*, **12** [11], 227–29 (1931).—In the new building of Simonds Industries, Inc., Fitchburg, Mass., several novel features have been introduced. Beside being a windowless plant depending entirely on artificial sources for illumination, all conditions will be controlled. The steel construction was done by a noiseless electric welding process instead of by riveting. An important feature will be noise absorption through acoustical walls, ceilings, and other means, with an outer facing of brick for architectural effect. A detailed description of some of the innovations in this plant is given. Illustrated. See also *Ceram. Abs.*, **10** [2], 154; [6], 429 (1931). E.J.V.

Developments in modern glassmaking. ANON. *Bull. Amer. Ceram. Soc.*, **10** [12], 353 (1931); *Pottery Gas.*, **56** [652], 1394 (1931). E.J.V.

Kaolin and its preparation. M. POHORZELECK. *Z. Ver. deut. Ing.*, **75** [31], 994–96 (1931); *Feuerfest*, **7** [10], 155 (1931).—Different slip methods used for the purification of kaolin are described. M.V.K.

Economics of the nonmetallic mineral industries. X. Traffic departments and freight rates. RAYMOND B. LADOO. *Rock Prod.*, **34** [24], 25 (1931).—Establishment and use of proper freight rates, checking freight bills, and routing are vital to most of the

rock-products industries. Check must be made on local freight clerks' or station agents' classifications or rates. Rates to new locations must be established frequently. Competitors' rates and rate changes must be watched. All rate changes and prospective changes must be considered in respect to future operations. For Part IX see *Ceram. Abs.*, **11** [1], 65 (1932). W.W.M.

Economy in research activities. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **10** [12], 343–44 (1931).—In explaining the recent announcement of the SOCIETY that it will not print any paper which will appear elsewhere in English other than as a reprint from its *Journal*, the question is raised as to what practice is the best for all concerned where results of research are to be made available to the public. Another question raised is whether it would not be better for governmental bureaus or experimental stations to leave to particularly interested groups the printing and distribution of research reports. E.J.V.

Industrial progress in twenty years. F. J. SOLON. *Glass Ind.*, **12** [12], 247 (1931).—In the past twenty years we have not only changed our manners, our ways of doing things, and our point of view, but we have also learned a great deal. S. summarizes fifteen principal items that we have learned. E.J.V.

Aims and purposes of the Clay Products Institute. L. B. LENT. *Jour. Clay Prod. Inst. Amer.*, **1** [1], 3–4 (1931).—The Clay Products Institute is an organization which concerns itself with the structural use of clay products and is not a trade association. E.C.C.

The Clay Products Institute from the standpoint of the structural engineer. S. C. HOLLISTER. *Jour. Clay Prod. Inst. Amer.*, **1** [1], 17–18 (1931). E.C.C.

Can the Clay Products Institute supplement the work of the A.S.T.M.? C. L. WARWICK. *Jour. Clay Prod. Inst. Amer.*, **1** [1], 13–16 (1931).—The Clay Products Institute can aid and supplement the work of the A.S.T.M. by accepting representation on its committees and by advocating the use of A.S.T.M. standards and specifications for heavy clay products. E.C.C.

Radiant heat absorption in water-cooled furnaces. W. L. DEBAUFRE. *Amer. Soc. Mech. Eng. Adv. Proof*, 7 pp.; *Mech. World*, **90** [2337], 375 (1931).—Deducting that heat which passes away with the waste gases from the heat in the flame as estimated from the chemical composition of the fuel, D. compares that remaining with the radiant heat estimated from the formula $(T_g/1000)^4 - (T_w/1000)^4$, where T_g and T_w denote respectively the absolute temperatures of the flame (estimated from the composition of the waste gases) and the temperature of the steam. This expression has to be multiplied by numbers ranging from 660 to 2290. It was found that in three sets of trials a marked decrease in these values occurred, which is attributed to the tubes becoming gradually coated with scale. E.P.R.

Heating boiler test with western coals. ANON. *Power Plant Eng.*, **35** [7], 434–35 (1931).—Results of tests at the Midwest Power Exposition made by the Commercial Testing and Engineering Co. on a 70-h.p. Kewanee boiler equipped with a Whiting Model C stoker which fed Ill. and Ind. coals, show interesting efficiencies and the practicability of using low-priced western coals in low-pressure heating plants when proper equipment is provided and given adequate operating attention. E.P.R.

Use of low-grade fuels. ANON. *Queensland Govt. Mining Jour.*, **32** [10], 413 (1931).—The "Turbine" forced-draft furnace has proved very valuable in regard to the wide range of low-grade fuels it can burn. E.P.R.

Figuring electric power rates. THEODORE MAYNZ. *Factory & Ind. Management*, **82** [6], 784–86 (1931).—A method is given for figuring and comparing power charges and rates. E.C.C.

America's finest firebrick plant. ANON. *Clay-Worker*, **96** [4], 205–17 (1931);

Brick Clay Rec., **79** [8], 334–65 (1931).—The history of the A. P. Green Fire Brick Co. from its inception in 1910 is briefly traced. The new plant, No. 3, has been laid out with the ultimate in view, as when completed it will occupy an area 1000 sq. ft. and it will not be necessary to change any one department in bringing the plant from its present four tunnel-kiln capacity up to ten-kiln capacity. A detailed description of the layout and equipment of the plant is given. Illustrated. See also *Ceram. Abs.*, **10** [11], 784 (1931). E.J.V.

Every worker an inspector. MANSFIELD VITREOUS ENAMELING CO. *Ceram. Ind.*, **17** [6], 449–52 (1931).—The Mansfield (Ohio) Vitreous Enameling Co. has an efficient wage incentive and quality-control system which is presented and discussed. W.W.M.

Cost accounting. W. J. REESE. *Oil & Fat Ind.*, **8**, 343–44 (1931).—The advantages which a technical training gives to chemists and chemical engineers in fitting them for cost-finding in process industries are explained. H.H.S.

Technical Congress of Ceramics. H. C. *Rev. mat. constr. trav. pub.*, No. 263, pp. 153–56*B*; No. 264, pp. 164–68*B* (1931).—In May, 1931, in Paris, the following papers were presented: (1) "The scientific methods of study of clays according to the combined use of chemical analysis, microscopic examination, and ceramic tests," by FELIX CHALAMEL (see *Ceram. Abs.*, **10** [9], 661 (1931)); (2) "A report of the study of kilns," by V. BODIN and P. GAILLARD (see *Ceram. Abs.*, **10** [4], 290 (1931)); (3) "Practical observations on the conduct of intermittent kilns," anonymous; (4) "Firing with heavy oil in the ceramic industries," by ADRIEN LEDUC (see p. 127, this issue); (5) "Dry distillation of raw materials used in ceramics," by MARC LARCHEVÊQUE; (6) "Modern mechanical handling in the ceramic industries," anonymous. M.Y.H.

University degrees in building science. ANON. *Times* [London], Sept. 22, 1931.—Manchester Univ. announces the institution of a degree course, covering 3 years and including the study of French and German, leading to the degree of Bachelor of Technical Science. H.H.S.

Influence of the Royal Society of London on scientific thought in the American colonies. F. E. BRASCH. *Sci. Monthly*, **33**, 336–55 (1931).—Mass. Bay Colony was represented by 9 Fellows of the Royal Society, Conn. by 1, Pa. by 3, Va. by 3, R. I. by 1, and N. C. and S. C. by 1. These Fellows are considered in turn, beginning with John Winthrop, Jr., who was elected F.R.S. in 1663. H.H.S.

Ceramics at the German building exhibition. EBERHARD HERFELDT. *Sprechsaal*, **64** [29], 550 (1931).—Ceramic products and objects exhibited at the German building exposition held in Berlin included structural clay products, majolica, white ware, terra cotta, glass, stoneware, and ceramic machines. M.V.K.

Exposition of the State Meissner Porcelain Manufacture. CHARLOTTE STEINBRUCKER. *Sprechsaal*, **64** [29], 550 (1931).—S. describes a special exhibition of historic porcelain and stoneware objects manufactured by the State Meissner porcelain plant. See also *Ceram. Abs.*, **10** [4], 312 (1931). M.V.K.

Italian pottery and glass trade. ANON. *Pottery Gaz.*, **56** [653], 1509 (1931); abstracted from *Ind. Silicati*.—Trade in bottles and sheet glass is not good and only mirror and artistic glassware report fair business. Business in pottery has declined. Electrotechnical goods alone experience good business, with almost all factories having full orders. See also *Ceram. Abs.*, **10** [9], 635 (1931). E.J.V.

New Polish pottery. ANON. *Pottery Gaz.*, **56** [653], 1551 (1931).—A new pottery factory equipped for a large output has been established in Orzesze, Upper Silesia. The factory is about to conclude an agreement with the Giesche Upper Silesian Porcelain concern to obviate competition. E.J.V.

BOOKS AND CIRCULARS

Technical Writing. T. A. RICKARD. John Wiley and Sons, Inc., New York. 3d ed. 337 pp. Reviewed in *Elec. World*, **98** [18], 794 (1931).—No more concise and interesting book exists that treats the subject as well. It is professional instead of academic. G.R.S.

Economics for Engineers. E. L. BOWERS AND R. H. ROWNTREE. McGraw-Hill Book Co., Inc., New York. 490 pp. Reviewed in *Elec. World*, **98** [19], 838 (1931).—This is a text for engineers whereby what might be called theoretical economics is adapted to the more definite and practical aspects found in business and engineering. Principles are selected and applied carefully to examples and the scope of the work pertains largely to manufacturing in its marketing and cost-accounting aspects. The book is well written and illustrated. G.R.S.

Materials Handbook. G. S. BRADY. xxiii + 588 pp. Reviewed in *Chem. & Ind.*, **50** [44], 893 (1931); for abstract see *Ceram. Abs.*, **10** [9], 668 (1931). G.R.S.

Mining laws of Great Britain. E. P. YOUNGMAN. Bur. Mines, *Information Circ.*, No. 6516, 15 pp. (Free.) This report gives a digest of mining laws, giving regulations pertaining to the rights of American citizens to own and operate mines in foreign countries. R.A.H.

Geophysical Abstracts. XXX. F. W. LEE. Bur. Mines, *Information Circ.*, No. 6558, 30 pp. (Free.) A monthly review is given of books, patents, and articles on geophysical prospecting. For Part XXIX see *Ceram. Abs.*, **11** [1], 56 (1932). R.A.H.

Present-day geophysics. F. W. LEE. Bur. Mines, *Information Circ.*, No. 6469, 5 pp. (Free.) L. gives a simple explanation of fundamental aims and methods of the science of geophysics. R.A.H.

PATENT

Ceramic product. STUART M. PHELPS. U. S. 1,832,913, Nov. 24, 1931. The method of producing a ceramic product which consists in preparing a mixture of clay and pitch, baking the mixture, crushing the baked product, mixing the crushed baked product with another body of unbaked mixture of clay and pitch, and shaping and firing the second mixture.

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A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions, and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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Vol. 11 **February, 1932** **No. 2**

EDITORIALS

GREETINGS

The year 1931 has passed. Passed like a night when we lay awake waiting for the dawn to break.

The fact that activities in the building trade came almost to a cessation during 1931 has greatly affected our ceramic industry even to the extent of compelling many of our members to lay down their tools.

It has so happened that I was elected to fill the honorable position of President and to direct the affairs of this SOCIETY—aggressive in all its undertakings—at perhaps the most trying period in the history of the SOCIETY.

Yet it must be said with pride and praise that everybody, the officers and crew, have stood by loyally and helped steer the ship up stream. Our SOCIETY has, even during this period of unemployment and adversity, lost but a small percentage of its membership, has instead improved its position both financially and otherwise, and is now as always before the guiding light for all of us who need it. Our hearts are with the SOCIETY in its work and we want to cheer and cherish it on to greater endeavors.

I do not venture to make any predictions for the year 1932 but I can only, as all of us do, hope that the dawn has come and will bring with it the expected improvement in business and prosperity to our members.

ECKARDT V. ESKESEN,
President

TOUGH GOING

Mighty comforting is the fact that the present hard times and national contentions have been experienced before in equal severity, and are always followed by splendid times and harmonious coöperations.

Advancements in civilization seem periodically to require a complete breakdown of man's complacency and smugness, morally, intellectually, and physically. Readjustments should be welcomed. As difficult as affairs are, they not only must be endured, but they should be endured with cheerful expectation and thoughtful planning for readjustments.

A Methodist minister, experienced and successful, would not accept appointments to churches that were free from indebtedness. A mortgage was to him evidence that the church members would have to scheme and work diligently to keep their morale as well as their morals. Without stress, morale lessened, morals slackened, and the solidarity or community unity was lost.

Paternalistic guidance and provision can be carried too far. This is so in the home and in the nation. Care for the needy is a just act, but to give care beyond that which is needed is degrading to the recipient. Our federal, state, and city governments are writing into statutes altogether too many paternalistic guidance and provision acts. There has been too much of this by corporations, supposedly in the interest of their employees.

So it is in trade competition. During the War, manufacturers made large profits on products of inadequate quality which could not be sold today. Plants extended and multiplied. All who would work were employed at large wages. It was a defeating round of excessive compensations and expenditures. Stocks and bonds were inflated beyond their intrinsic value. The day of reckoning came—hard times. Our whole industrial and social being became mortgaged to the hilt by readjustment necessities. Loss of business, of incomes, of values, and even loss of employment have caused suffering and worries, apparently more intense because of the days of plenty just passed. The needed readjustments are difficult to make.

It is certain that no permanent good can come from paternalistic legislations. No compensation by statutes will meet the needs of these times. Man, by individual efforts, must meet the situation.

Displacement of hand labor by machines has reduced product values and has made products more generally available. Corporation ownership is being dispersed, hence more people are participating in the corporation profits. Men are having more time for self-improvement. This should be and is a beneficial arrangement which needs no operative acts by legislation. Legislation in such matters creates an unnatural set-up that is defeating.

The "times" are going to be bettered only by voluntary collective action, each industrial and business group taking care of its own problems. Associated group products of a standard quality sold at a reasonable profit will require that men and corporations shall frankly join in the search for the most economical ways and means of producing and distributing, and shall collectively insist on quality standards and a minimum selling price.

This will require researches on materials and processes. It will require analytical studies of customers' requirements. It will require systematic collecting, recording, and studying of information.

There has never been a time, more than at the present, when trade and technical associations should have the unanimous support of business firms and corporations. Through no other agency can business be righted. Men and corporations must in unison work themselves out of this depression, each group for itself. Dependence on or interference by the governmental acts will be defeating. Let each one have the head and heart stimulant of self-dependency. Permanent advances in civilizations have been and now can be made only when man diligently and honestly works out his own salvation.

PAPERS AND DISCUSSIONS

HISTORY OF SILICA BRICK[1]

By Thomas N. Kurtz

I. Introduction

Silica brick were first imported into the United States about 1868 and were used in the first open-hearth steel furnaces in 1869. Imports from Wales, Scotland, and Germany continued until 1889, when American manufacture had developed sufficiently in Pennsylvania to supply all American needs. The quantities of silica brick imported were small because the open-hearth furnace was not extensively used in the early days, most of the steel then being made by the Bessemer process in which silica brick are not needed.

II. Development in America

The manufacture of the first silica brick in the United States is sometimes attributed to Isaac Reese of Manorville, Pa., and sometimes to Samuel Johnston of Apollo, Pa., but the first authentic record of its manufacture is that of A. J. Haws & Son at Johnstown, Pa., in 1884. Jesse L. Hartman of Hollidaysburg, Pa., opened one of the earliest ganister rock operations at McKee's Gap, Blair County, Pa., in 1883. Mr. Hartman shipped 200 tons of ganister rock to Haws in December, 1884. This shipment was used for making the first American silica brick. It was followed by shipments of 1046 tons in 1885 to the same company, and these shipments continued with increasing volume for almost twenty years. In February, 1886, Mr. Hartman shipped 59 tons to Harbison & Walker, Pittsburgh, Pa., where that company made its first silica brick at the old Star Fire Brick Works.

An interesting detail about the early manufacture of silica brick is that of Harvey E. Lowery, formerly a foreman and molder of silica brick at Mt. Union and Hawstone, Pa. When he was a boy at Hyndman, Pa., a few silica brick were made there and an Englishman, who had been brought there to supervise the mixing and manufacture, made a great mystery of the mixture used. The brick at that time, as at present, were made of ganister rock (quartzite) with about 2% of lime as a binder. The Englishman slaked the lime in a little room built especially for him above the grinding pan. He allowed no one in this room with himself. Lowery, then a boy of about fourteen, with the normal boy's abnormal curiosity, climbed up on the roof and there secretly watched the Englishman through a little window. After satisfying himself that the only secret of the mixing room was the slaking of ordinary lump lime with equally ordinary water, Lowery reported his discovery to the boss, then Mr. Hoblitzelle, one of the owners of brick works. As a result, the Englishman soon lost his "soft job."

Another interesting incident is told about the early manufacture of silica brick by another company. The senior member of the firm sent one of his sons to Wales to learn the details of the process. He secured various jobs at silica brick plants and obtained

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (Refractories Division).

the desired information. After this, he and his family began making silica brick, having sworn to secrecy all their employees. To retain in their own hands some mystery not shared by all employees, an arrangement was made whereby, after the lime was slaked and ready to be put into the mixture, a member of the firm, one of the family, was always called upon to inspect the batch of slaked lime, then in the state of milk of lime. It was always the custom, after this inspection, to bring from the office a bottle of dark-colored liquid from which a carefully measured small quantity was invariably poured into the batch of lime. Some time later, a competitor broke into the firm's office one night, stole the bottle of dark liquid, had it analyzed, and found that the liquid was ink.

A similar air of mystery and selfishness pervaded the manufacture of silica brick for many years, fully as much as in other lines of business in the "good(?) old days." Manufacturers were suspicious of one another. They seldom openly visited competitors' factories, and frowned upon visits of competitors or unknown people to their own factories. By 1900 the policy was not quite so narrow, but it continued to some extent until the organization of the Refractories Manufacturers Association in 1912. By this time, a later generation of brickmakers was in charge of the various companies, and soon the policy of narrow-mindedness gave way to an exchange of ideas on methods of manufacture which greatly benefited the producers and consumers of silica brick and other refractory materials.

The Basic Brick Company of Johnstown, Pa., was an important manufacturer in the nineties. This company, as well as Isaac Rees & Sons, was absorbed in 1903 by the Harbison-Walker Refractories Company.

In 1899, W. H. Haws of Johnstown, Pa., built the first silica brick plant at Mount Union, Pa. This marked the beginning of the building of silica brick plants near the raw material deposits, rather than in the consuming steel centers.

In 1901, another plant was built by Mount Union Silica Brick Company, which property was acquired by the General Refractories Company of Philadelphia, Pa., in 1914. About 1903, a plant was built at Alexandria, Pa., by the Stowe-Fuller Company of Cleveland, Ohio.

In 1907, the American Refractories Company built the first silica brick plant in the middle west at Joliet, Ill., utilizing ganister shipped from quarries near Baraboo, Wisconsin. This company's properties were acquired in 1923 by the General Refractories Company.

In 1909, the General Refractories Company built a plant at Sproul, Blair County, Pa.

In 1911, the Mount Union Refractories Company built its Mount Union plant, which is now owned by the North American Refractories Company of Cleveland, Ohio, and in 1913 the Standard Refractories Company built a plant at Claysburg, Pa. The latter was acquired by the General Refractories Company in 1922.

Additional large plants have been built during the past fifteen years at East Chicago, Ind., Wylam, Ala., Niles, Ohio, Joliet, Ill., and in Pennsylvania. Somewhat smaller plants have been built in the west in Colorado, Montana, and New Mexico.

III. Present Producing Capacity

At present the producing capacity is somewhat in excess of the demand. This is due partly to the heavy demand during the World War, caused by

extensive use of silica brick in this country, exports, and inefficiency in manufacture and use.

Another reason for the over-development in the silica brick industry is the mistaken conception of the business formerly held by many people in the industry and some who wanted to get into it: that "anyone can make brick," that the business is exceedingly profitable and simple with "easy money" to be made, and that the only essential is a supply of suitable ganister rock. The fallacy of these ideas has been fully demonstrated in the past eighteen years. As a matter of fact, the business, like any work that is worthwhile, requires intelligent and experienced management and technical control. In addition, it requires heavy permanent investment of capital, considerable working capital, easy access to market, cheap fuel, and suitable sales connections.

The census of manufacturers of the United States shows the production of silica brick as follows:

Year	9-inch equivalent	Value	Average sales price/M
1919	211,420,000	$10,914,898	$51.63
1920	?	?	?
1921	104,990,000	5,220,640	49.73
1922	186,547,000	7,533,409	40.38
1923	258,388,000	12,858,067	49.75
1924	204,338,000	10,084,373	49.40
1925	235,877,000	11,280,127	47.82
1926	266,409,000	13,614,033	51.10
1927	245,881,000	12,756,994	51.88

Considerably more than one-half of the silica brick produced are used in open-hearth steel furnace construction and maintenance. Other important uses are in by-product coke ovens, copper-refining furnaces, glass tanks, electric furnaces, and coal-gas retorts.

IV. Shapes of Brick Manufactured

The sizes and shapes of silica brick manufactured may be divided into four groups: (1) 9 inch straights (9 by $4^1/_2$ by $2^1/_2$ inches), (2) 9-inch series of shapes, (3) ordinary large shapes, and (4) difficult shapes.

The standard 9-inch straight brick is the one size most extensively used. About 40% of the entire production of silica brick is made up of this size, for it is used in nearly all straight walls of furnaces, and in many other parts. The standard 9-inch series of shapes include wedge brick, arch brick, etc., used along with 9-inch straights in arches, roofs, and various complicated parts of furnaces. The ordinary large shapes include comparatively simple shapes larger than 9-inch, but do not include coke-oven shapes and other difficult and complicated brick which come in the last-mentioned group.

In the early stages of development of the manufacture of silica brick, the output was almost exclusively standard 9-inch straights and 9-inch series of

shapes. At that time practically the only large shapes were the rectangular tile, 12 by 9 by $2^1/_2$ inches, the large 9-inch (9 by $6^3/_4$ by $2^1/_2$ inches), the $13^1/_2$-inch binder ($13^1/_2$ by $4^1/_2$ by $2^1/_2$ inches), and a door-jamb tile.

About thirty years ago, the limited use of a few additional large shapes began and increased from year to year, so that by about 1910 there were thousands of shapes in use. In fact, the mania for large shapes, special shapes, intricate, and sometimes impossible shapes, grew until nearly every engineer wanted from two or three shapes to hundreds of special shapes for each furnace planned, or for each new battery of ovens. At first one or two of the manufacturers of silica brick encouraged this (or at least did not discourage it) and often did not use good judgment in accepting engineers' designs or in themselves designing unnecessarily intricate or numerous shapes and sizes. The engineers did not appreciate the trouble and expense involved and the manufacturers sometimes shut their eyes to it in order to get business against severe competition and to hold it. Sometimes the possession of expensive molds by one manufacturer gave him a limited monopoly on certain trade.

Soon this heavy expense became unbearable to manufacturers. Those who knew their costs began charging the consumer additional amounts for the special molds necessitated by new designs of shapes. This naturally led to conferences between manufacturers of silica brick and the designers of furnaces and ovens. The situation became a little better, and some of the consumers coöperated with the manufacturer. Others took advantage of the severe competition prevailing and forced manufacturers to furnish expensive special molds at their own expense rather than to lose the orders for standard shapes as well as for special shapes. The conferences also brought to the attention of the consumer the possibility of saving time by using simple standard stock sizes and the inevitable waste and cost to the consumer caused by the multiplicity of new designs and the intricate nature of many shapes.

V. Standardization and Simplification of Sizes

The beginning of real coöperation of a mutually beneficial nature between producers and consumers came with the organization of the Refractories Manufacturers Association in 1912. A committee on standardization found 130 different shapes in the standard 9-inch series, many of them differing by only a small fraction of an inch in thickness and used for exactly the same purpose. Concerted action on the part of the manufacturers, backed by the coöperation of the consumers, soon eliminated 108 of the so-called 9-inch shapes, and the remaining 22 were standardized and given general publicity in the trade, with resultant economy of time and money to both producer and consumer.

After this step, an engineer could take the book of standards of the Re-

fractories Manufacturers Association, make his calculations from the sizes and tables found there, and give to his purchasing agent a list of quantities and sizes which would be intelligible to the purchasing agent and to any manufacturer of refractories. Every one concerned knew (1) that when a No. 1 wedge was mentioned it referred to a brick 9 inches long, $4^1/_2$ inches wide, $2^1/_2$ inches thick at the large end, and $1^7/_8$ inches thick at the small end, (2) that it tapered endwise, (3) that it was a standard 9-inch shape manufactured in large quantities for many different consumers, (4) that it was usually kept in stock for immediate shipment, and (5) that it was included among the standard 9-inch series of shapes on which from the beginning of the industry the base quotations always applied. This uniformity of size extended to all the regular 9-inch series and greatly simplified the purchasing agent's work in buying and the bricklayer's work in using the material.

The benefits to producer and consumer alike, in economy of time and money, were so apparent that the work of standardization was soon extended to large 9-, 12-, $13^1/_2$-, 15-, and 18-inch brick. Soon the newly standardized 12 by $4^1/_2$ by 3 series of straights and wedges were widely adopted for steel furnace roofs. The 12 by 6 by 3, 15 by 6 by 3, and 18 by 6 by 3 standard series of straights and wedges were also adopted extensively where numerous shapes of similar size and design had been formerly used.

Considerable simplification of special shapes, too, has resulted. Impossible shapes usually have been eliminated or altered, and extremely difficult and expensive shapes have in many cases been improved to make them practical. Extreme bulk in a single shape or piece has usually been replaced with a number of smaller pieces; sharp points have been slightly rounded and filets have been placed in corners formerly square; shapes with holes in them have frequently been replaced with two or four segments forming the hole and filling the same space; shapes of extreme length, width, or thickness have often been replaced with two or more pieces of practical proportions. All of these changes have resulted in additional economies, for silica brick material is extremely friable and excessive breakage results when any of these points is disregarded. This coöperation should continue and should become general, because industry is not static but dynamic and new developments are constantly arising which, to be handled with least economic loss, require full exercise of the intelligence, experience, and technical knowledge of both producer and consumer.

VI. Early Development of Manufacture

Commencing in 1885, the manufacture of silica brick in the United States was for many years conducted in fireclay brick plants. About 1895 a plant was built at Johnstown, Pa., by the Basic Brick Company especially for

manufacturing silica brick. Other separate plants, or parts of plants, were soon built for making silica brick exclusively, and the necessarily different methods of manufacture were gradually developed.

During the early development of the industry, the ganister rock was purchased by all manufacturers from Jesse L. Hartman of Hollidaysburg, Pa., but as the industry grew in size and importance many manufacturers acquired and developed ganister properties of their own.

The crushers and grinding pans used in manufacturing fireclay brick were soon found too light for crushing and grinding ganister rock, and in a short time much heavier machinery was generally adopted. The little old cast-iron crushers with chilled iron dies (jaw liners) were, by about 1900, replaced in practically all cases with larger heavy steel crushers; the dies were made of high carbon steel or manganese steel. The grinding pans of the old style gave way to a heavy new type, and soon the wearing parts were made of steel instead of iron.

In molds, too, steel gradually replaced the cherry and maple woods which had been used instead of the pine and poplar suitable for fireclay brick molds. The cutting abrasive action of the particles of rock in the silica material was found to be too much for anything other than steel. Thus, steel molds were uniformly adopted, and only in a few cases were molds of wood with steel lining used. Only in rare cases where one to ten pieces of simple design were needed, were wooden molds used.

Radical changes took place in other parts of the plant also. The old drying floors, "hot-floors," gave place to tunnel driers with steel rack cars and steel pallets for the brick, the drying floors being retained only in some cases for the drying of intricate special shapes not suitable for placing on steel pallets and racks of drier cars. The wheel-barrows for taking the dry brick from the floor to the kiln disappeared, as the drier cars on which the brick were placed when molded went through the drier and to the kiln where the brick were removed and set (stacked or piled) for firing.

The little rectangular kilns and occasional small round kilns gradually were replaced by large round kilns of more efficient and less wasteful type.

The wooden buildings, storage bins, run-ways, etc., were replaced with steel and brick and concrete. Steep and irregular grades and run-ways disappeared and level, smooth wharves and platforms took their place. The works offices were removed from little shacks or dusty corners of factory buildings to clean modern buildings with good light and modern appliances and conveniences.

The outside of the plants, too, took on a different appearance, and the old "brick-yard" which looked much like a "dump" became a real factory with modern well-painted buildings, paved drive ways, parking, and trees.

VII. Present American Manufacture

As the American silica brick plant developed to what it is today, manufacturing methods improved with increasing demand so that the American silica brick of today is vastly superior to the early product.

This superiority is obtained by using hard quartzite with a minimum of impurities, by accurate technical and mechanical control of mixing, grinding, and sizing, by modern improved methods of molding or forming, by firing at high temperatures with pyrometric check and control, and by rigid inspection of the finished product.

The quartzite, or ganister rock, as found in the natural state, contains varying percentages of soft or sandy rock and rock carrying an excess of objectionable impurities including alumina and alkalis. To produce the best silica brick, manufacturers eliminate this off-quality material. This quality is regularly and systematically checked by visual examination, by physical tests, and by analysis.

In the same way the mix, the grind, and the sizing are carefully controlled by mechanically measuring or weighing the material going into each batch, by screen tests, inspection, and analysis.

This careful attention to the product is continued during the molding or forming of the brick and shapes and during the drying, preparatory to setting the product in kilns for firing. Most plants now have machines for molding 9-inch straights and other standard sizes, thereby eliminating the variation found in handmade material. In the drying, too, great care is exercised by prolonging the time of drying intricate large shapes to prevent cracking.

When the product has been properly dried, it is set in kilns in the way best suited for each shape and in the proper part of kiln where danger of cracking is reduced to a minimum. Great care is exercised in this work and much extra expense is involved to protect special shapes by casing them with smaller sizes of brick and by boxing and bridging over them to keep the weight of other brick off them.

After setting the brick in kilns, the firing is conducted in accordance with a definite schedule covering time, draft, temperature, and expansion of test pieces, the temperature being checked by recording pyrometers up to 1600°F and by optical pyrometers thereafter, while the draft is recorded on gages and controlled with dampers.

After the kiln has been fired to the proper temperature and soaked for a specified time at the maximum temperature, firing is stopped and the kiln is sealed with brick and clay, after which cooling is accomplished under carefully scheduled control.

When the kiln is cooled and ready to empty, the brick are removed by experienced men, each crew of four men having, in the best plants, an inspector with them at all times, so that the product, when finally loaded in

cars for shipment or placed in storage sheds, has had eliminated from it the defective brick.

Furthermore, on the finished product, tests are made in the laboratory to check lime content, P.C.E., complete analysis, specific gravity, porosity, spalling, residual expansion, modulus of rupture, etc.

For the future, leading manufacturers make tests and conduct research work in plants and laboratories on materials, on means and methods of production, and on the product in use.

North American Refractories Company
Cleveland, Ohio

ACTIVITIES OF THE SOCIETY

ENAMEL DIVISION TRUSTEE

Walter Lindemann has been elected Trustee for the Enamel Division to take the place on the Board of Trustees which will be made vacant by the election of E. P. Poste as President of the SOCIETY.

DIVISION NOMINATIONS

The Nominating Committees of the Refractories and White Wares Divisions have submitted the following reports:

White Wares Division

Chairman:	H. M. Kraner Edward Schramm	*Secretary:*	A. H. Fessler Louis Navias

Refractories Division

Chairman:	S. M. Phelps	*Secretary:*	H. E. White
Vice-Chairman:	R. A. Heindl	*Nominating Committee:*	A. E. R. Westman E. H. Van Schoick

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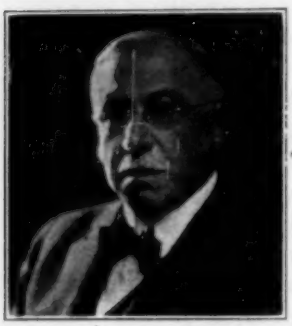
CHARLES L. ALLEN KNIGHTED BY KING OF SWEDEN

President and General Manager of Norton Company; director of banks, savings, institutions, life insurance companies, and welfare federations; member of several federal, state, and city committees; advisor to national, state, and city officers and leaders; these and more are Mr. Allen's present interests.



CHARLES L. ALLEN

For fifty years with Norton Company beginning as bookkeeper, serving forty-six years of these fifty as General Manager; beginning when the plant had one small kiln and so directing the company's affairs until the home plant in Worcester, Mass., alone has two million square feet of floor space, one hundred periodic kilns, and three tunnel kilns, as well as manufacturing plants in England, Germany, and France. This is the notable record for him who was bookkeeper, poor in worldly goods but rich in judgment and personality.

Note that rapid rise in four years from bookkeeper to general manager!

In Norton Company Mr. Allen is respected and loved more than ordinarily, not because of paternalistic acts or attitude but because it is known that he is leading to larger and more profitable being the enterprises in which his associates are employed and in which they share.

Because in Worcester, there are many from Sweden who have benefited largely from the several civic and business enterprises in which Mr. Allen has had a directing interest, King Gustaf V of Sweden made Charles L. Allen a knight of the first class of the Order of Vasa.

Opportunities for service and honor for accomplishments keep coming to Mr. Allen because his associates have profited by the many trusts they have placed in him. He has handled each responsibility studiously and patiently.

Honorary banquets, engraved trophies, congratulatory telegrams from the President of the United States, from Calvin Coolidge, from governors, and from men ranking high in all walks of life were given Mr. Allen in recognition of fifty years of continuous service as an official at Norton Company.

When men like E. V. Eskesen, H. C. Kleymeyer, the late W. E. Wells, and Charles L. Allen advance rapidly from lowly to directing positions in private affairs, beginning without either financial means or special training, rapidly acquiring and always increasing their facilities for achievements, there must be a reason. These men are studious beyond the limits of their vocations. They know and appreciate literature and art. They busy their minds in many ways outside of their business tasks, giving largely of their time and mind to humanitarian affairs. They are ever mindful of their co-laborers, their associates, and their neighbors. Never snobbish in thought or deed, they assume responsibilities for the sake of their community and for social, business, and political groups.

The breadth and the depth of their scholarly participating interests, vocationally and avocationally, is the secret of their successes. Thoughtful application of oneself to the problems of making collective enterprises most helpful and profitable to all concerned is the habit of the successful men. To be much of a factor in collective affairs one must acquire the means, both mentally and physically.

Self-made men? No more than each must be who succeeds and no matter how much formal school training one may have.

Charles L. Allen is honored at home and abroad because he has equipped himself for service to others and because his life and works are a lesson and an inspiration.

CHARLES FERGUS BINNS MEDAL[1]

The Charles Fergus Binns Medal for 1931 has been awarded to R. Guy Cowan of the Cowan Potters, Inc., of Rocky River, Ohio.

The Binns Medal for achievement in ceramic art was established in 1925 by the Alumni of the New York State College of Ceramics at Alfred University, Alfred, N. Y., to commemorate the twenty-fifth anniversary of the directorship of Dr. Charles F. Binns.

Mr. Cowan, who receives the award this year, has achieved a great deal in beautifying art pottery. He is a graduate of Alfred University, receiving his training from Dr. Binns in the class of 1907. He has been a teacher in the schools of Cleveland and is now head of the Cowan Potters, Inc., of Rocky River, Ohio. It is his influence that has brought Cowan ware to its present leading position in ceramics.

RETIREMENT OF DR. CHARLES FERGUS BINNS

On December 31, 1931, Dr. Charles F. Binns announced his retirement from the directorship of the New York State College of Ceramics at Alfred University, Alfred, N. Y. For thirty-one years Dr. Binns has directed the Ceramic School, and it is only

[1] For previous awards see *Bull. Amer. Ceram. Soc.*, 10 [2], 53 (1931).

because of the state retirement laws that he is obliged to relinquish the active administration of the School.

The permanent successor for Dr. Binns' position has not yet been announced, but the duties of director will be taken over by Dr. M. J. Rice and Prof. C. R. Amberg, members of the staff, for the remainder of the year. The classes which Dr. Binns has been teaching will be carried on by various members of the faculty. The classroom work will be supplemented by lectures from recognized experts who will be brought to the Ceramic School during the second semester for short courses of lectures in their respective fields.

NEW MEMBERS RECEIVED IN DECEMBER

Corporation

Koppers Research Corp., O. O. Malleis (voter), 1628 Koppers Bldg., Pittsburgh, Pa.
New Jersey Porcelain Co., Stephen Wenczel (voter), New York Ave. & Plum St., Trenton, N. J.
Ohio Insulator Co., M. W. Manz (voter), Barberton, Ohio.

Personal

George J. Barker, College of Engineering, University of Wisconsin, Madison, Wis.
Henry H. Baumgartner, 11 Davidson St., Belleville, N. J.; President, Essex Engineering Co.
C. A. Hoffman, Harrop Ceramic Service Co., 310 W. Broad St., Columbus, Ohio.
Paul V. Johnson, 6712 North Central Ave., Chevy Chase, Md.; Assistant Ceramic Engineer, Bureau of Standards, Washington, D. C.
Frank G. Roberts, 6 Roxbury Place, Mt. Washington, Baltimore, Md.; Porcelain Enamel & Mfg. Co.

Student

Owen Mason Burrows, Massachusetts Institute of Technology, Cambridge, Mass.
Howard R. Erwin, Iowa State College, Ames, Iowa.
Royden C. Hutchison, Pennsylvania State College, State College, Pa.
John H. Isenhour, North Carolina State College, Raleigh, N. C.
Glen H. Latimer, Ohio State University, Columbus, Ohio.
Harold F. MacDonald, University of Washington, Seattle, Wash.
Ole A. Olson, Iowa State College, Ames, Iowa.
Eugene L. Seeley, Iowa State College, Ames, Iowa.
Le Roy Kern Sosey, Ohio State University, Columbus, Ohio.
Cecil H. Turner, Ohio State University, Columbus, Ohio.

Membership Workers' Record

Corporation		Student		Personal	
S. S. Cole	1	A. F. Greaves-Walker	1	G. A. Balz	1
Ray Higgins	1	D. A. Moulton	3	F. M. Hartford	1
J. R. Smith	1	F. H. Norton	1	E. E. Krauss	1
		J. B. Shaw	1	R. T. Stull	1
		Hewitt Wilson	1	R. H. Türk	1
		Office	3		
Total	3	Total	10	Total	5
		Grand Total	18		

ROSTER CHANGES IN DECEMBER

PERSONAL*

Anderson, Thomas B., 218 N. Ninth St., Cambridge, Ohio (907 Walnut St., Coshocton, Ohio.)
Fackt, Geo. P., Gladding, McBean & Co., 660 Market St., San Francisco, Calif. (2901 Los Feliz Blvd., Los Angeles, Calif.)
Gauger, Alfred W., Pennsyvlania State College, State College, Pa. (University Station, Grand Forks, N. D.)
Gill, Joseph W., Building Materials Research Laboratory, 23 S. Damen St., Chicago, Ill. (Bureau of Standards, Lord Hall, Ohio State University, Columbus, Ohio.)
Irving, Donald R., Carquinez Hotel, Richmond, Calif. (1438 Poinsettia Place, Hollywood, Calif.)
Longbotham, Harry, 206 Hillcrest Blvd., Millbrae, Calif. (210 Peninsular Ave., San Mateo, Calif.)
Meents, Elmer A., 229 N. Jefferson St., Dayton, Ohio. (Kankakee, Ill.)
Pittenger, J. E., 5102 Hazel Ave., Philadelphia, Pa. (Membership transferred from H. Paul Holz.)
Reynolds, Myron E., 5114 29th Ave. N.E., Seattle, Wash. (235 E. 6th St., Stockton, Calif.)
Schwetye, Fred H., Vandalia, Mo. (2015 Fair Ave., St. Louis, Mo.)
Webster, Charles E., 2215 Elmwood Ave., Springfield, Ohio. (727 Marquette Ave., S. Milwaukee, Wis.)

UNKNOWN ADDRESSES OF MEMBERS

The Secretary of the AMERICAN CERAMIC SOCIETY will appreciate information concerning the present location of the persons listed below.

Abney, Charles L., Doctors Inlet, Florida.
Anderson, M. E., Wellsville, Mo.
Andrews, B. S., 1103 W. Illinois Street, Urbana, Ill.
Arthur, Edwin P., 2074 Santa Rosa Ave., Pasadena, Calif.

Baranowski, William G., 2721 North Mason Avenue, Chicago, Ill.
Bidleman, W. J., Chicago Fire Brick Company, 1321 Conway Building, Chicago, Ill.
Blakeslee, H. G., 16 Woodcrest Ave., Atlanta, Ga.
Bloor, Colin A., 110½ E. Main Street, Peru, Ind.
Boving, Paul C., Hynes, Calif.
Boyd, James M., 16 Melborune Road, Norwalk, Conn.
Brauer, Hildegard, 13915 Kinsman Road, Cleveland, Ohio.
Brown, Thomas G., Gurney Foundry Co., St. Laurent, Quebec, Canada.
Busbey, Robert R., Canton, Ohio.
Butler, E. L., 111 W. Washington Street, Chicago, Ill.
Byrnes, A. Marietta, Mississippi State College for Women, Box 1321, Columbus, Miss.

Callaghan, J. P., c/o Teaque Hotel, Montgomery, Ala.
Cameron, Walter F., Delavan, Ill.
Carpenter, Cranston H., 403 West Fourth St., Mansfield, Ohio.
Central Refractory Trust, Most 18, Kusnetzky, Moscow, U.S.S.R.
Coats, G. Roger, 610 Wesley Bldg., Philadelphia, Pa.
Coffin, Leon B., P. O. Box 920, Pittsfield, Mass.
Cole, A. H., 456 Wealthy Ave., Grand Rapids, Mich.
Corry, John J., 1420 West Broadway, Enid, Okla.
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NECROLOGY

Herbert Sinclair

Herbert Sinclair, president of the Star Porcelain Co., Trenton, N. J., and the Frenchtown Porcelain Co., Frenchtown, N. J., died in New York on November 15.

HERBERT SINCLAIR

Mr. Sinclair was prominently identified with the ceramic industry in New Jersey. He was born near Bloomsbury, N. J., and received his early education in the public schools at Milford. His training was along commercial lines and he was graduated from the Stewart Business College.

He went to Trenton in 1893 and began his business career as a bookkeeper at the Brian Pottery. In his spare time he kept books for the late Dr. Charles P. Britton who conducted a drug store. Dr. Britton later assisted Mr. Sinclair in the formation of the Star Porcelain Co.

Mr. Sinclair held directorships in the Trenton Savings Fund Society, Fitzgibbon & Crisp, Inc., and the United New Jersey Railroad and Canal Co.

He had been a member of the AMERICAN CERAMIC SOCIETY since 1911.

NOTES AND NEWS

SHORT COURSE FOR CLAYWORKERS AT IOWA STATE COLLEGE

The annual Short Course for Clayworkers was held at Iowa State College, Ames, Iowa, January 20–22, 1932. The program was as follows:

(1) "Electricity as a Source of Heat for Ceramic Products," by D. A. MOULTON, Ceramic Engineering Department, Iowa State College.

(2) "Manufacture of Refractories," by the LACLEDE-CHRISTY CLAY PRODUCTS CO.
(3) Welding demonstrations.
(4) "Natural Gas as a Ceramic Fuel," by D. A. MOULTON.
(5) "Limitations in Coloring Heavy Clay Products with Glazes," by PAUL E. COX, Head of the Ceramic Engineering Department, Iowa State College.
(6) "Manufacture of Abrasives," by RICHARD J. PENNY, Carborundum Co.
(7) "Hard Facing with the Electric Arc," by G. F. CLIPSHAM, Lincoln Electric Co.
(8) "Hard Facing Wearing Surfaces with Oxyacetylene Torch," by E. F. SMITH, Haynes Stellite Co.
(9) "Experiences with Stellited Plow Shares and Other Farm Machinery," by W. T. SAXON, Collins Farms Co.
(10) Demonstration on hard facing.
(11) "Railroad Tunnel Kilns," by D. A. MOULTON.
(12) "Some Experiments on Surface Coloration of Face Brick," by A. D. DRAKE, Rockford Brick & Tile Co.
(13) "Regulation of Combustion in Coal-Fired Kilns," by C. G. HARMAN, Ceramic Engineering Department, Iowa State College.
(14) "Once-Fired Glazed Structural Clay Products," by H. S. LEWIS, Ceramic Engineering Department, Iowa State College.

CALENDAR OF MEETINGS

Organization	Date	Place
AMERICAN CERAMIC SOCIETY	February 7–13	Washington, D. C.
American Chemical Society	March 14–18	New Orleans, La.
American Foundrymen's Assn.	May 2–6	Philadelphia, Pa.
American Gas Assn.	October 10–16	Atlantic City, N. J.
American Society of Mechanical Engineers	June 27–30	Huntsville, Ont.
American Society for Testing Materials	June 20–24	Atlantic City, N. J.
Common Brick Mfrs. of America	February 1–6	Louisville, Ky.
Electrochemical Society	April 21–23	Baltimore, Md.
National Assn. of Manufacturers of Pressed and Blown Glassware	March 8	Pittsburgh, Pa.
National Brick Manufacturers Research Foundation	February 7–13	Washington, D. C.
National Paving Brick Assn.	February 10–12	Chicago, Ill.
Sand-Lime Brick Assn.	February 3–4	Washington, D. C.
Scientific Apparatus Makers of America	May	Wernersville, Pa.
Structural Clay Tile Assn.	February 17–19	Chicago, Ill.
Tile & Mantel Contractors' Assn. of America, Inc.	February 9–12	Rochester, N. Y.

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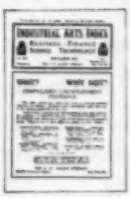

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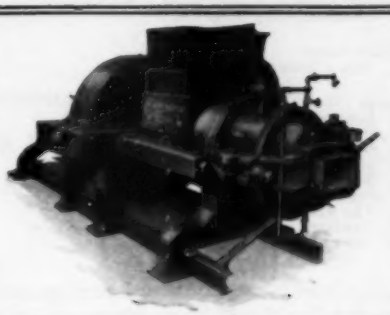

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